AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

Vol. L[illegible] No. 10 JANUARY, 1948

Contents

H. M. STATIONERY OFFICE

LONDON · EDINBURGH · MANCHESTER · CARDIFF · BRISTOL · BELFAST

Price Sixpence Published Monthly

AGRICULTURE
THE JOURNAL OF THE MINISTRY OF AGRICULTURE

Editorial Offices: Ministry of Agriculture and Fisheries, 55 Whitehall, London, S.W. 1. Telephone: Whitehall 3400

VOL. LIV **No. 10** **JANUARY, 1948**

THE IMPORTANCE OF GRASS CONSERVATION

SIR R. GEORGE STAPLEDON, C.B.E., M.A., F.R.S.

I DO not propose to discuss the technicalities of making hay or silage, or those connected with drying grass. I want to emphasize certain points which, in my view, render the proper conservation of grass not only a matter or urgent, immediate importance, but one which will certainly become of increasing moment in the years ahead.

Future of our Flocks and Herds There is general agreement that in the national interest we should greatly increase our herds of livestock. We need greater numbers, and we need animals of a higher quality. To breed and rear the requisite numbers will take time; and in proportion as we increase our flocks and herds, so must we make available the necessary feed. If we proceed to a plan, both as to numbers and feed, then, and largely on the resources of our own farms, we should be able after a few years to face with assurance all the uncertainties and perils of the wholly unpredictable future—at least in respect of meat and milk. I can imagine nothing that would contribute as much to home-grown winter feed for stock as the adoption everywhere of the best possible methods of grass conservation.

Wholesale Waste of Grass Nutrients I am convinced that none of us even yet quite realizes the immense potentiality of this island for grass production. The chief reason for this lack of realization, I verily believe, is the painful fact that, taking the country as a whole, probably more grass nutrients are wasted than are eaten, or in any event, than are properly and economically assimilated and converted by the animal. The reason for all this waste is not only that by far the greatest tonnage of grass that is conserved is cured in the

form of hay—in the main, of very questionable quality; I suspect that ill-controlled grazing, accompanied by excessive trampling and fouling, accounts for far greater waste of nutrients than any other single cause. We have here to take into account not only actual waste—grass that is never eaten—but something of even greater importance, namely the waste of *potential* herbage. The gross tonnage of material, actual and potential, which is wasted is high in proportion as the conditions for the growth of grass are excellent; that is to say, in regions of abundant rainfall and relatively mild climate—the larger proportion of our agricultural acres.

Increasing Overall Yield of Grass Nutrients It is essential at this point to insist upon an aspect of grass conservation that receives all too little attention. It is almost impossible to get the best out of even permanent grass without periodic resort to the mowing machine. The animal is not all-sufficient, and its efficiency as a regulator of grass growth decreases proportionately as the grass grows well—on good pastures under conditions of adequate soil moisture. I would go as far as to say that it is quite impossible to get the best out of leys without continued recourse to the mowing machine. Herein lies a fundamental difference between the management of the ley and that of permanent pasture. The ley is capable of bursts of growth much more rapid than any permanent pasture, and therefore far more nutrients are liable to be wasted.

It is just here, however, that we have a measure of the great possibilities latent in the ley. The ley can be made to produce grass at a time when it will be most needed, to a much greater extent than can permanent grass. The key to producing grass in abundance for grazing at any given time is to ensure an adequate root system and an adequate period of unhampered growth before the herbage will be needed. I hold, therefore, that cutting for silage or for grass drying, or for that matter for the making of a light crop of leafy and herby hay, should be an integral part of ley management. The alternating of periods of growing on to cutable material, and growing on to grazing material, and the alternating of cuts with grazing, give immense scope for proper ley management. By proper ley management I understand the purposeful endeavour to achieve four ends in particular: (a) a good and penetrating root system—this to encourage rapid and continued elongation of leaves, and to create an abundance of fibrous roots eventually to be ploughed in; (b) an extension of the length of the effective grazing season, and an abundance of grazing throughout that season; (c) an abundance of grass of high nutritive value in a condition for optimum conservation over as long a season as possible; and (d) the creation of conditions that make for the minimum of waste of actual and potential nutrients.

I do not say that it is necessary regularly to alternate conservation cuts and grazing on one and the same field, but I do say when abundant conservation cuts alternate with grazing as part of the ley management all over the farm, then, leaving alone all question of the grass conserved, the gross amount of grazing eatables per unit of area per year will be vastly increased. What is more, the average nutritive value of the herbage eaten every day will be increased, and the amount of nutrients wasted in grazing will be decreased.

To mow-over as necessary for the good of the sward, and to push growth forward to a later date, is sensible as far as it goes, but it is much wiser so to regulate procedure that all mowing is aimed also at cutting grass for conservation.

Size of Paddocks and Watering Facilities

The trouble is that if our grassland, and our leys in particular, are to be managed with a view to ensuring a minimum of waste and a maximum of conservation, the size of paddocks must be reduced. It is essential to make flexibility in management as easy as possible. Decisions need to be made quickly, and small paddocks lend themselves to quick decisions. If the weather favours rapid growth the animals can be kept to less paddocks than normal for the time of the year, and the other paddocks put up for conservation cuts. These others will not only yield grass for conserving extra to programme, but, because rested and cut, they will give abundant grazing later, and at a time when it may be urgently needed. I am fully aware that fencing and laying on water present great difficulties today. But I am thinking ahead all the time and against the day when we shall enormously have increased our head of livestock. I argue that there is not a moment to be lost, and that progressive farmers—alike on large and small farms—should start methodically sub-fencing and reducing the size of paddocks and adding to water points. We, as a nation, I stand convinced, will never again be able to afford so much flagrant waste of one of our most essential, and cheapest-to-be-won, assets—grass.

It will be argued that small paddocks and mechanization are not compatible. In good husbandry, however, everything is a matter of degree and of just compromise. We must consider the needs of our country and of our agriculture as a whole. Meat and milk are high priorities—just how high, we could know only if it was possible to hold a plebiscite on the question of the foods the housewife and the household most greatly yearn for these days. Certainly there is need for smaller paddocks in the more essentially stock districts than in the more essentially arable; and more so on dairy farms than on other stock farms. Be that as it may, speaking quite generally, I am sure I am not alone in thinking we have already gone much too far in the direction of running fields toegther, and in doing away with sheltering hedges. To do the best with animals, we should be able to exercise highly intelligent control, and that does not mean range grazing; further, the smaller the paddocks, within reason, the more even the distribution of the excreta. I do not think there is any evidence to suggest that heavy concentration of animals on relatively small areas at a time is harmful, provided the rotation from place to place is frequent, sensible and well arranged. A system of rotation of animals that involved the periodic moving from grazing areas to cut areas would be wholly to the good, because in turn all areas would not infrequently get relatively prolonged rests from livestock of any sort.

I have advisedly placed great stress on the importance of the mowing machine as an aid to grazing management. I think that if this were fully realized, and if the enormous waste of grass that most present-day methods involve were fully appreciated, the generality of farmers would think again, and think hard as to the feasibility of improving their methods of grass conservation. Apart altogether from what I have said as to management, the conservation of grass remains a crying need on its own account. Taking the two needs together—grazing and conservation—I have come to the conclusion that it is wrong to advise an individual farmer to contemplate all-out ley farming unless he is able and willing to supplement his haymaking by an additional method of conservation; to do so is no less than an act of sanity and a national obligation. I may therefore fittingly conclude this article with a few observations on hay, silage and dried grass.

Hay I have been about on farms and amongst farmers last summer to a greater extent, and in a more intimate way, than for several years, and I have been impressed by certain facts. There would seem to be a very general consensus of opinion that baling hay on the field is a far from satisfactory method of making good hay. I have seen some lovely hay made by tripoding, and I honestly believe this "laborious" method should be much more generally explored. Then there is the firm belief that good meadow hay has a peculiar value. I cannot help wondering whether the equivalent of meadow hay could not be made from leys cut in a leafy condition, and cured by tripoding—I think this should be further explored. It is true that the more mature (i.e., stemmy and fibrous) the growth when cut for hay, the easier it is to make and handle. On the other hand, not only is the nutritive value lower, but to allow growth to run on into a heavy and excessively smothering crop, is bad for the sward. I think, therefore, that the whole technique of growing and curing hay calls for a vast amount of fundamental and practical research. I have been reported as saying, in effect, that there should be no hay stacks by the 'sixties. No, not quite that ; we want less hay and that of a much higher quality. Hay as hay has a value and a usefulness peculiar to itself, and, as I have been reminded, if well cured and nicely bathed in the sun it helps to take care of vitamin D in the ration fed to stock in the winter.*

Silage I think it quite impossible to overstress the importance of silage these days. It is through silage, well made, that the majority of farmers can most economically grow and secure a protein-rich winter feed. There is a fair range of days over which cuts can be most properly made for silage. I do not think we are sufficiently exploiting this fact, and I feel that far more could be done to help the small man in particular by local organization. I should like to see peripatetic gangs with appropriate implements, each in charge of a well-trained (and expert silage-maker) foreman, in operation in all the higher rainfall and grassy districts. For a start, silage to be of high quality needs to be made on a contract or cooperative basis for the smaller farmers ; *For*, rather than *By*, is what needs to be stressed.

Dried Grass For the time being, we are compelled to place greatest reliance on silage as the means ready to hand to conserve grass of high protein content. I am, however, one of those who wish to see grass drying developed on a really comprehensive scale in this country. Here is a matter about which we have time to formulate a real plan ; to be ready to dry grass in sufficient tonnage to help feed, at a later date, the greatly increased head of stock towards which we should be aiming. I am informed by those who have closely studied the question, that neither the steel nor the fuel (not needed in vast quantities anyway) that would be necessary should be regarded as serious limiting factors. The all-round economic and social gains per unit of each employed would be difficult to match by any other utilization of a similar tonnage. Dried grass and silage are clearly complementary to each other, and indeed, if we were drying grass wholesale it would frequently be necessary to supplement the drying (e.g., in periods of unusual growth) by silage-making. Dried grass has great merits of its own. It can be transported long distances—a very important matter in this country with its locally erratic and regionally differential rainfall. It is easy to handle and easy to take from place to

* See, for example : MAYNARD, L. E., Animal Nutrition (Second edition), New York, 1947.

place on the farm. Dried grass in quantity, and stored at strategic points, might well prove to be the salvation of the hill sheep (and cattle!) industry, particularly in winters of exceptional rigour. It is a good feed of wide application; it could also be made to have a decisive effect on the poultry industry, and the poultry, in turn, would increase markedly the fertility of our soils. I have more than an idea that by growing special herbages on selected areas and drying the produce, we should find a suitable means of countering, in a natural way, the deficiencies or imbalances which so persistently reveal themselves on particular fields and in particular localities. That, however, is a matter for research.

LESSONS OF THE THORNBURY EXPERIMENT Ever since I visited Thornbury in the summer, I have been turning over in my mind the implications of the Milk Marketing Board's purposeful adventure in contractual and cooperative drying. To my mind the details and economics of working in a first year are of small account; it is a proper assessment of the implications alone that matter. I think there is no doubt whatsoever that with good will and hearty cooperation, drying could be organized on a contractual and cooperative basis; indeed I see no other way in which we can hope to get grass drying on to the smaller farms. The implications, however, go much further, for, as I have said, silage-making also demands outside (i.e., contractual) help. So also does the proper treatment of permanent grass, and still more important, the proper pre-treatment of permanent grass with a view to subsequent ploughing.

The same is perfectly true of the cultivations demanded for reseeding, no matter whether the reseeding is direct or after a run of crops. To move in the direction of contractual operations, all conducted by men skilled in each, is, I am sure, the only way today to get the best out of our grasslands. It is, too, the only way to get the best out of our small farms. Let the small farmer be a stock master *in excelsis*; this is quite enough responsibility for a good man and true. The rest must be done *for* him, more skilfully, and in the long run more cheaply, than he could hope to do it for himself. That is the far-reaching implication of the Thornbury venture, and what is more, the drying, the silage-making and the cultivations could, and should, be brought together under one organization. The organization in each case, like that at Thornbury, should be local in character, and I should like to see such an organization set on foot under all manner of different auspices in all manner of different places. Here, for example, cooperative enterprise amongst the farmers themselves; there, private enterprise initiated by a far-seeing contractor or firm of contractors.

At present costs of labour, with present scarcities, and with the skilled techniques demanded in the performance of all operations, I contend that the small and relatively small stock farmer cannot possibly do the best for himself, for his land or for the nation unless he can call upon first-class contracting services to assist him in all major operations. It would be far more exhilarating to the small and grass-minded farmer to contract with somebody to grow and prepare the feedingstuffs he requires from his own farm, than to buy them (enter into a contract for them) from elsewhere—if he could!

SEEDS MIXTURES FOR THE MODERN LEY

WILLIAM DAVIES, D.Sc.
Director, Grassland Improvement Station, Stratford-on-Avon

WHY do we in Britain use seeds mixtures at all? Clearly the answer is so that we may maintain grasslands of a type superior in both yield and nutritive value to the sward that would be brought about by merely letting the land fall down to grass. We are, however, particularly fortunate in this island of ours that our arable land will readily fall down to a sward, whether or not we sow a mixture of seeds. This natural sward formation also usually takes place with sufficient rapidity to ensure the minimum danger from soil erosion. In many other countries soil erosion presents the farmer with a grassland problem of the first order, and he must at all times be prepared to sacrifice everything to produce a closely knit turf so that the rain is absorbed into the soil rather than run off the surface and perhaps remove with it the top soil.

As with every other agricultural crop, the farmer sows his seeds mixture to control nature and to determine for himself the class of herbage he produces. Under most conditions of soil or climate throughout the world, nature will quickly provide an herbaceous cover. In the more primitive types of agriculture the grass ley, even today, is unsown. Much as with our own medieval agriculture, where the corn stubble was left for a year or more, so today in the native agricultures of Africa the "ley" is unsown and the period in "grass" is regarded as a rest period for land normally and otherwise put to the usual run of arable crops. Modern science has amply confirmed the wisdom of the practice of so resting arable land. From the viewpoint of maintenance of a healthy soil condition, which makes possible the continued use of crop-growing land over prolonged periods, the ley, whether or not explicitly sown, provides an essential and a fundamentally pivotal crop in the rotation.

Even in primitive agricultural systems the ley is utilized for grazing or for the provision of fodder at some time or another in its history. In modern agricultural practice, however, the sown ley is valued as much for its ability to produce high quality animal feed as for its attributes to provide improved condition in the soil. It is now becoming apparent that the more productive the ley, and the more animals it will maintain, so proportionally does it become a better implement for promoting health and condition in the soil itself. The high-class ley, in which there is a proper balance of grasses and clovers, can therefore provide for the maximum carrying capacity in terms of high-producing animals, and at the same time it will be instrumental in promoting a rapid building up of soil fertility. Biological activity in the soil will tend to be at a maximum when the ley is fully utilized by the grazing animal. Under these conditions the animal will be browsing on leafage which is of high nutritive value, high in nitrogen and in minerals. Dung and urine, both of which will therefore be rich in plant foods, will be returned to the soil.

The grass-legume sward is capable of quickly absorbing animal excreta, and the process of growth, as well as decay, proceeds at an accelerated pace. All the evidence therefore suggests that the grazed sward acts much as a sponge with regard to animal excreta; the greater the growth, the higher the carrying capacity of the sward. The more animals it feeds, the greater the aggregate of dung and urine dropped, which, in a biologically active soil, promotes an enhanced production of grass and maintains high fertility in the soil. The essential point in ley farming is that such swards of grass and clover should be regarded as a pivotal part of the farm rotation:

pivotal in two major respects, namely, (1) to provide the maximum of animal feed during the period in grass, and (2) to build up soil condition and general fertility to the point where maximum crops of corn or roots can be grown in the arable shift.

The Modern Ley is a Crop To ensure the full development of these two prime functions of the ley, the farmer must know what seeds mixture to use when sowing land down to grass. He must also know how best to establish his ley, and further he must be conversant with the broad principles of grassland and ley management to maintain his pastures and meadows at the highest possible pitch of efficiency. The following notes relative to seeds mixtures, their establishment and utilization, are designed to form a guide to the solution of this problem.

During the past half century a considerable amount of work has been accomplished relative to the whole question of sensible seeds mixtures. Robert Elliot, Fream, Faunce de Laune, Sutton and Carruthers did pioneer work in the closing decades of the nineteenth century, and their work served to focus attention on the problems of mixtures. The general trend was towards the use of very complex mixtures, where almost every available species was included in the one sowing. The fundamental work done by Gilchrist at Cockle Park during the early years of the present century did much to simplify the prescription and to use only those species of undoubted pastoral worth. Gilchrist for the first time brought detailed scientific study to bear on the grassland problem as a whole and showed that not only was the type of seeds mixture important but also that phosphates (in relation to soil fertility) and pasture management were of paramount value in the establishment and maintenance of his leys.

Gilchrist also stressed the importance of using proper strains in terms of wild white clover, leafy (N.Z.) cocksfoot, and late-flowering red clover. His work, following upon that of Elliot, paved the way for an appreciation of ley farming in the sense that we know the term today. The later work of Stapledon and his colleagues gave emphasis to strain in a wider variety of pasture plants and has led to a still further simplification in seeds mixture prescriptions. The modern ley is to be regarded as a crop, designed to cater for specific demands on the farm, and the seeds mixture is of the simplest form commensurate with the fulfilment of the purpose to which the ensuing ley is to be put. The advent of approved leafy, high tillering strains in the grasses and the development of more robust forms in white clover (e.g., S100) makes it possible greatly to reduce seed rates. Many farmers now sow no more than 10–15 lb. of seed per acre, compared with the traditional sowings of 30–40 lb. used in the long ley mixtures of even a decade ago.

The Quest for Round-the-Year Pasture The experiences gained during the course of the past half century have culminated in the fairly general use of reasonably sensible and well-balanced mixtures among the majority of farmers. Prescriptions for general-purpose seeds mixtures will differ from farm to farm and from seeds merchant to seeds merchant, but on the whole these differences amount to little in terms of the resultant output of meat or milk. It has become increasingly evident that given a sound basis leading to a sensible blend of grasses and clovers, minor differences in the general-purpose mixture have little beyond an academic interest. More important to the farmer than small differences in total yield of one mixture against

another is the seasonal distribution of that yield. The farmer must now be more concerned with an equable spread of pasture growth throughout the season and must seek to find ways and means of extending the seasonal production of grassland. We require our leys to grow right through the summer and as late into the autumn as possible. We also want growth to start early in spring so as to close the winter gap as much as possible.

The concept of the simple, specific-purpose seeds mixture using specially bred leafy and winter green strains of the grasses makes it possible to provide a more even seasonal distribution of pasturage than has hitherto been thought possible. In the past our leys have been based largely on ryegrass, or at best ryegrass has always tended to predominate in our seeds mixture prescriptions. The ryegrass-dominant ley stands high in total production; it commences growth early in spring, produces an excessively high flush in May and June and normally provides adequate grazing in September and October. It is, however, strikingly seasonal in growth and extremely sensitive to the weather. Even under conditions of ideal temperature and moisture during the summer period, the ryegrass ley tends to fall in production, and indeed may almost cease growth, during July and August. This fall in production becomes still more accentuated and may also be unduly prolonged when dry weather intervenes at this time of year.

Closing the Summer Gap Current investigational work has gone some way towards closing the summer gap in pasture production—a gap which is emphasized on farms and in districts that rely wholly on the ryegrass-dominant ley. The work of the Grassland Improvement Station, for example, has already shown that even in years like 1947, when the late summer was abnormally dry, the production of ley grass can be maintained during even the driest weeks. The principle is manifestly as follows:

(1) to use maiden seeds, that is, to sow each year a breadth of seeds without cover crop and to rely on them to provide an abundance of post-midsummer keep;

(2) to use special-purpose leys based on cocksfoot with either lucerne or S100 white clover (and in some districts sainfoin leys also) with a view to maintaining high yields of nutritious pasture right through the summer.

(3) to arrange for early cuts of hay or silage (on these special leys in particular) so that maximum vigour is built up in the swards.

The provision of summer pasturage in dry years as well as wet is, therefore, a function not only of seeds mixtures, with due regard to the use of appropriate strains, but also of particularized management designed to foster maximum growth at specified periods. The use of nitrogenous dressings applied in late May and early June will also assist in closing the summer gap.

The summer gap is relatively a simple problem, although an important one in relation to our national milk supply. If we are to ensure an even supply of liquid milk throughout the late summer, the dairy farmer must learn to put into practice the results of experimental knowledge already gained. Given the knowledge of how to use leys to the best advantage, there can be no adequate reason for the sharp declines in production that we witness in every dry summer in Britain. True, this fall in milk yield is accentuated because of the tendency towards autumn calving which has taken place in recent times. The bigger factor influencing the annual fall in production of milk in late July and August is, however, nutritional. It is consequent upon the drop in yield of our pastures and meadows. The

point that matters is that it is within our reach to correct the fall in so far as it is due to restricted flow of pasture nutrients. The use of special leys based variously on cocksfoot (and the new strains of meadow fescue) with appropriate legumes will go a long way towards filling the gap. The practice of sowing all long-duration (three-year leys and over) mixtures early in the spring and without a cover crop is another way of ensuring plentiful growth of leafy herbage in the driest weeks of summer.

The following seeds mixtures would be appropriate for long-duration leys where a primary objective of the fully established sward is to cater for maximum production in the post-midsummer period (July-August).

(*a*) *Cocksfoot and White Clover*

	lb. per acre
Cocksfoot (S37)	12
White clover (S100)	2
	14

When properly established the cocksfoot ley may either be grazed in spring or cut for silage (or very early hay) in mid-May. The pasture should then be rested from mid to late May until required for grazing in July. Where required specifically for August keep, the hay cut could be deferred until the end of May and then followed by a 6–8 weeks' complete rest to provide for the maximum of leafy growth when required for grazing. It is an advantage to use the leafy strains of cocksfoot because of their capacity to produce a leafy aftermath. It is an added advantage to apply 1–2 cwt. per acre of a nitrogenous manure in late May or early June to provide for a maximum bulk of succulent leafage.

(*b*) *Cocksfoot with Lucerne*

	lb. per acre
Cocksfoot (S37)	3
Lucerne (Grimm)	15
White clover (S100)	¼
	18¼

The cocksfoot-lucerne mixture provides invaluable summer keep in districts where lucerne is known to flourish. Where July keep is specially required, the lucerne mixture can be cut for hay in early June and grazed from July onwards. Where August keep is the main requirement, the lucerne mixture may provide two cuts of hay or a cut of hay followed by a cut for silage (the latter taken in early July) and the subsequent aftermath grazed in August. In some districts the leafy strains of meadow fescue (e.g., S53) may prove better companion plants in lucerne mixtures than cocksfoot, while in other cases leafy timothy (e.g., S48) may prove more appropriate. It is always a good safeguard to add a small seeding of S100 white clover, which not only assists in the control of weeds but also ensures a high-class sward if the lucerne itself fails to flourish. This is particularly true where lucerne is being tried out in districts in which it has not normally been grown in the past.

Closing the Winter Gap We have now discussed the problem of the summer gap. The more difficult problem facing the dairy farmer is the much longer winter gap in pasture production. For some time yet we shall have to rely upon conserved fodder to provide for the winter period. There are a whole range of problems here concerning methods of conservation, whether in the form of super-quality hay, silage,

or dried grass. All these methods aim at reproducing in winter the standard of nutrition provided by high quality grazing leys during the summer flushes.

Current trends in research work and in practical experience among pioneering farmers, however, suggest that much can be done to provide pasturage both in early spring and again late into the autumn. Experiments in progress at the Grassland Improvement Station are aimed at still further closing the winter gap. The leafy and winter green strains of ryegrass, cocksfoot, timothy and meadow fescue will all play their part in this development. The cocksfoot mixture quoted above can be used to provide both late autumn pasturage and an early bite in spring. To be of maximum usefulness they will need to be given appropriate management and manuring to cater for these out-of-season periods. Thus to provide for keep in November and December, the cocksfoot leys will need to be rested completely from September and preferably dressed with nitrogen (1-2 cwt. per acre sulphate of ammonia or other nitrogen) before the middle of that month. The cocksfoot ley used in this manner should provide abundant keep before Christmas and so treated should also come away very early in spring to provide an early bite in March and April.

A more difficult period for which provision will have to be made is that from Christmas to mid-March. High-class ryegrass leys on fertile soils will start growth in April; and a dressing of nitrogen in February will bring them on still earlier, in some years as early as the middle of March. To cater for January and February, reliance will have to be placed on the winter green strains of timothy and meadow fescue. Such a mixture as the following is under test at the Station and shows some promise of being able, under specific management, to provide midwinter keep:

	lb. per acre
Timothy (S48)	6
Meadow fescue (S53)	6
White clover (S100)	2
	14

Under some conditions it may be admissible to add 2-3 lb. per acre of S37 cocksfoot to this mixture. There is some evidence to suggest that the seed rates as given above should be regarded as maxima, so that still further reduced seed rates may be used.

The timothy-meadow fescue mixture can be used to provide either hay, silage or grazing during the summer. Appropriately managed and rested, it can appreciably cater for the July and August period. To give the maximum at midwinter (January to mid-March) it must be rested from August onwards and preferably dressed with nitrogenous fertilizer at the beginning of the resting period. There is need for much more research into the whole of this problem, and especially to inquire further into the question of precise date–range relative to both manuring and management of different types of ley in relation to providing autumn, winter and early spring pasturage.

Our Grassland Potential The whole thesis of growing pasturage for foddering *in situ* during the winter and spring months is one of immediate practical interest. The solution of many outstanding problems would serve to add to the efficiency of pasture production and utilization in Britain. The thesis needs, however, to be viewed in relation to other methods of conservation, all of which aim at the provision of high-class nutrients throughout the winter. Anything that will

make it possible to extend the grazing season and to provide high quality material for the grazing animal throughout the whole of that season is of obvious value. The indications are that by using modern methods based on high quality leys, and employing approved strains of the major grasses and legumes, we shall within a few years proceed a long way towards closing the gaps in pasture production, not only in summer but in winter also. We in Britain, with our equable climate and relatively fertile soils, have before us a great opportunity for the development of our grasslands. The whole thesis of the ley in all its manifestations gives us great scope for exploiting the grass crop to the full. Nothing is more urgent than that we should extend our grazing season, for to do so is to cheapen our costs of production and to reduce the demands for labour involved in the winter foddering of our livestock.

THE CONSERVATION OF FODDER CROPS FOR WINTER FEEDING

From a paper read to the Farmers' Club on December 1, 1947 by

R. E. SLADE, D.Sc.

IT will be convenient to classify the principal fodder crops used for the feeding of our animals in winter into three classes: (1) cereals and legumes; (2) arable root crops and arable green crops; (3) leafy crops, such as grass and lucerne.

The yields of food value (starch equivalent and crude protein) per acre calculated from the average yield for the ten years to 1939 are given in Tables 1, 2 and 3.

Table 1. Cereals and Legumes

Crop	Yield of grain per acre *cwt.*	Yield of starch equivalent per acre *lb.*	Yield of crude protein per acre *lb.*
Wheat	18	1,500	250
Barley	16.4	1,300	190
Oats	16	1,100	190
Beans	16.3	1,200	460
Peas	14.8	1,300	380

Table 2. Arable Root and Green Crops

Crop	Yield of crop per acre *tons*	Yield of starch equivalent per acre *lb.*	Yield of crude protein per acre *lb.*
Sugar beet ..	8.6	2,900	212
Potatoes	6.7	2,780	315
Swedes	13.2	2,140	380
Mangolds	18.3	2,540	410
Sugar-beet tops ..	8.6	1,650	385
Cabbage	*20	2,950	670
Kale	*20	4,100	980

* estimated.

Table 3. Leafy Crops

Crop	Yield of crop per acre	Yield of starch equivalent per acre *lb.*	Yield of crude protein per acre *lb.*
One crop of hay from temporary leys	28 cwt.	1,100	280
One crop of hay from permanent grassland	20 cwt.	670	170
Dried grass (3 cuts)	50 cwt.	3,400	820
Grass silage (3 cuts)	12 tons	2,700	600 to 800
Intensive rotational grazing well managed	—	2,000	680
Grazing an ordinary pasture ..	—	760	180
Grazing a meadow	—	840	200
A well-managed field mown for hay, and the aftermath grazed	—	2,000	585
Dried lucerne (3 cuts) ..	50 cwt.	2,800	1,120
Dried lucerne (3 cuts) ..	60 cwt.	3,270	1,340
Lucerne silage	12 tons	3,000	1,100

It is not only the root crops which yield twice as much starch equivalent as cereals per acre ; grass and lucerne do also if they are kept growing all through the summer by cutting or grazing just as they are about to reach the flowering stage. The only crops which yield only 1,200 lb. starch equivalent per acre are the cereals or legumes which cease to grow early in June, and then for the rest of the summer they are ripening to form seed.

Badly managed grassland produces much less food than cereal crops—often only half as much. But well-managed grassland and root crops produce twice as much food value per acre as cereal crops. The grasses and clovers contain too much fibre for pigs and poultry to digest. They are most suitable for cattle, sheep and horses. They can, however, be usefully fed to pigs and poultry in small quantities.

Roots Leys or Cereals ? In general, a field of roots will grow twice as much food (for cattle, pigs or fowls) as a field of corn. Also a well-managed ley, either of grass or lucerne, will produce more than twice as much food for cattle, horses, sheep or goats as a field of corn.

Animals require protein as well as starch equivalent in their ration, so let us consider which are the protein-rich foods. First, there are the seeds of beans and peas, which produce 400-500 lb. of crude protein per acre. Except for these legumes, there are no other crops giving a high yield of protein per acre except those of which the leaf matter constitutes the food, e.g., cabbages produce 670 lb. crude protein per acre, kale 980 lb., dried grass 820 lb., good grass silage 600 to 800 lb., dried lucerne 1,120 to 1,340 lb. and lucerne silage 1,100 lb. These are the home-produced protein foods which we must use to balance the starchy foods—oats, millers' offals, mangolds, swedes, etc. Of these, only beans, peas, dried grass and dried lucerne are in a form for mixing with other foods to make a meal or cubes, a procedure which is important if these foods are to be used economically. Cabbage and kale are usually fed to cattle directly, but they can be made into silage or dried.

Silage-making and Grass Drying Our Government is financing a large development of groundnut cultivation in Africa, but I doubt whether this will ever provide us with all the protein food we need for our stock, though it may succeed in providing us with oil to make margarine.

The yield of shelled groundnut obtained in Africa is about 500 lb. per acre, and this gives 250 lb. of oil and 250 lb. of groundnut cake containing about 110 lb. of crude protein. It is a rich protein food, but the crop gives a lower yield of crude protein per acre than we get with any of our crops. It is probable that they will be able to improve methods of cultivation so as to obtain higher yields, perhaps double or even more, but even the yield of crude protein per acre would be very low compared with the yields we obtain in this country with our protein crops.

We ourselves should, therefore, get down to growing the feedingstuffs we require. In the grassland districts we can turn a portion of our ordinary permanent pastures into intensively cultivated grassland to feed our cattle. Large areas of permanent pasture now yielding 800 lb. of starch equivalent and 200 lb. of crude protein per acre can be made to yield an extra 1,200 lb. of starch equivalent and 600 lb. of crude protein. We know how to do this if we use fertilizers, and grass drying or silage for conservation of the crop.

In the arable areas, a great deal more food can be obtained from our temporary leys if we make silage or dried grass instead of, or as well as, hay. In the drier parts of the country lucerne can be grown and conserved. The pigs and poultry can have root crops grown for them to provide the starch equivalent without too much fibre, and the food can be balanced with dried grass or lucerne as a source of protein.

Roots Let us consider root crops, swedes, turnips and mangolds. They were very important crops before 1880, but since then they have fallen from favour. It did not pay to grow them when maize and imported oats were cheap. But since roots can produce a lot of food per acre and are a useful crop for cleaning the land, we shall probably find that it is again worth while to grow them. The root crops are low in fibre, and most of them can be fed to pigs or poultry as well as to horses and cattle. Sugar beet produces more food per acre than any other root crop.

Let us compare sugar beet with oats. An acre of sugar beet during the ten years to 1939 produced: 8.6 tons of root containing 2,890 lb. of starch equivalent, and 8.6 tons of tops containing 1,650 lb. of starch equivalent, or a total of 4,540 lb.; whilst one acre of oats produced 16 cwt. of oats containing 1,080 lb. of starch equivalent. Thus an acre of sugar beet produced more than four times as much food as an acre of oats.

Grass and Lucerne It is, however, to leys of grass and lucerne that we must turn to get the greatest increase in our supply of feedingstuffs for cattle. For pigs and poultry, dried grass and lucerne serve as a supplementary ration to provide protein and vitamins—they are fed up to 20 per cent of the ration. Grass is the best crop in the high rainfall districts, and lucerne where the rainfall is less.

Lucerne needs no nitrogenous fertilizers, while grass needs 6-10 cwt. sulphate of ammonia or other nitrogenous fertilizer per acre to get a full crop. Since leaf matter is the natural food of ruminants, grass or lucerne, dried or ensiled, are the best foods for cattle in winter. Perhaps the best proof of this is the well-established fact that cows fed on ordinary rations through the winter months give an increased yield of milk—usually 15-20 per cent when let out to grass in the spring. But if the cows have received a few pounds of dried grass or lucerne each day, the increase is quite small —less than 5 per cent. The cows fed with the dried leaf matter, and already giving a full yield of milk, have little to gain from the fresh grass, but the cows fed on ordinary rations obtain from the fresh grass something which

they require to give a full yield of milk. What this food factor is, we do not know. Is it a vitamin, or is it the better selection of proteins available in leaf matter ?

When we first produced dried grass in quantity (1926-32) it was used as a protein food. About this time, Canadian and Californian sun-dried lucerne meal was being imported into this country for inclusion in chicken meals to supply carotene as a source of vitamin A. These sun-dried lucerne meals contained 60-80 mg. of carotene per kilo. It was eventually found that dried grass had a carotene content of 200-400 mg. of carotene per kilo, and dried grass came to be valued chiefly for its carotene content.

Cod liver oil used to be added to poultry mashes, pig food and calf meal to supply vitamin A, but dried grass or dried lucerne with a high carotene content is now always used for this purpose, because cod liver oil soon loses its vitamin A potency when mixed with meal ; but the carotene in dried grass is stable.

In the feeding of calves, chickens and pigs, small quantities are useful for providing practically the whole range of vitamins including the B group. It seems to be well established, too, that pigs and cattle become more fertile, the sows rearing larger litters, and the cows being more easily got into calf in the winter months, if they receive a small portion of dried grass in their ration.

Value of Dried Grass Dried grass is now well established as an accessory feedingstuff to provide either vitamins or special proteins in which other foods are lacking. But if it is available in sufficient quantities, it is an excellent protein food. Good dried grass is a balanced food for milk production, 4 lb. being sufficient for the production of a gallon of milk, whilst lucerne is a high protein food which must be mixed with a starchy food to make a balanced ration.

I have already suggested that a proportion of our permanent pastures should become intensively cultivated grassland, so as to yield two to three times as much animal food as it does today ; and much of this might be in the form of dried grass or silage. We could then feed our dairy herds entirely on home-grown grass and we should get better yields of milk and have healthier livestock. It is only on grass drying farms that you will ordinarily find intensively cultivated grassland, for the fields must be cut or grazed to suit the grasses and not to suit cattle grazing on them, and this is never done consistently unless the surplus grass is wanted for drying. Imperial Chemical Industries fed a herd of dairy cows on dried grass at Dairy House, Middlewich, from 1932 to 1942, and Mr. Bennett in the Severn Valley is doing it today. At both these farms the dairy herds have been fed entirely on dried grass during the winter.

When feeding dried grass to cattle, we must know its protein content, and it is usual to divide it into three grades, for instance :

	Crude protein *per cent*	Protein equivalent *per cent*	Starch equivalent *lb.*	B. Carotene
Best	17 and over	11.4 and over	60	Over 100 mg. per kilo
Medium	14 to 17	8 to 11.2	58	—
Ordinary ..	12 to 14	6.5 to 8.5	57	—

4 lb. of best grade would make rations for 1 gallon of milk.
5 lb. ,, medium ,, ,, ,,
6½ lb. ,, ordinary ,, ,, ,,

High-yielding cows should have "Best" grade dried grass for milk production, but "Ordinary" grade would suffice for an animal giving only two gallons, or perhaps three gallons, per day.

In drying grass there is only a small loss of digestibility of the protein and practically no loss of starch equivalent.

Dried grass cannot be stored in a stack like hay because it is too springy. It does not settle down and so remains very bulky. It can be baled, and it is easily stored in this form. But for use as an accessory to other feedingstuffs, it is generally ground in a mill. It is unfortunate that the heat generated during milling raises the temperature of the meal and causes some of the carotene to be oxidized. Another method of storage is in the form of chaff made with an ordinary straw-chaffing machine. This packs and stores quite well in dry chaff houses, and is a convenient form for feeding to animals on the farm where it is made.

Silage Let us now consider silage. In the making of silage, wet vegetable material is packed together so as to exclude most of the air, but on the other hand, it must not be pressed down too tightly. Enzymes cause oxidation and the mass heats up with the formation of carbon dioxide and acids, of which lactic acid is most preferred. As it takes time for the mass to heat up, a silo cannot be filled in one day. A certain amount of the crop must be added to the silo each day or each two days, according to how it heats up. The addition of molasses to grass in the silo makes it easier to control the quality of the silage, for the molasses quickly ferments to form lactic acid, and high acidity is necessary to make good silage. Sometimes mineral acids are used to control the reactions in the silo ; they are used in Finland and Sweden to a great extent.

The labour required for making silage is quite considerable with any type of vertical silo. It should be less in pit or clamp silos, which are filled direct from the cart or tractor. A considerable saving of labour in silage-making will come from the use of the green-crop loader which is used by grass and lucerne driers.

In the making of silage, a quarter to a third of the starch equivalent in the crop is lost, but usually the loss of digestible protein is low. Of course, if the silage is badly made, 50 per cent of the feeding value of the crop can be lost. The carotene is preserved in good silage.

Although a good many farmers are making silage and using it for the feeding of their herds, most are feeding it in only small quantities, perhaps 5-15 lb. per cow daily. I have heard of no one feeding his herd entirely on silage for the whole of the winter. To do this it would be necessary for the milch cow to eat 100 to 150 lb. of silage per day.

To sum up, silage is a really good feedingstuff preserving the protein and the carotene in the crop. There are losses of starch equivalent, but these are counterbalanced by the simplicity of the apparatus required to make silage.

Hay I have not mentioned hay except to give some values for the amount of food produced by an average field of permanent grassland, 670 lb. starch equivalent and 170 lb. crude protein. But it is possible to do a good deal better than this if we use fertilizers to grow the crop and the right methods of making hay, and these are the first steps to be taken to bring our grassland into intensive cultivation. Grassland should have lime if it needs it (and most of it still does) ; it should also have a dressing of phosphate fertilizer from time to time, and some grassland needs potash, but on the clays there is usually no shortage of potash. All grassland

needs nitrogen, and for making hay on land which is otherwise fertilized, about 4 cwt. sulphate of ammonia or other nitrogenous fertilizer should be used. About 60 per cent of the nitrogen in the fertilizer appears in the crop as crude protein, and there is no need to fear that 4 cwt. is over the optimum dose for grassland.

Hay is often made by cutting the grass when it is very mature and letting it lie in the swath, which is turned once or twice, until it is completely bleached. It is then stacked. Other hay is insufficiently cured. It then heats in the stack giving a sweet smelling brown hay of very low feeding value.

Good hay is made by cutting the grass when it is in early flower and then putting it into cocks, after once turning, as soon as possible It is best in the cock in two days and before any rain has fallen. When this hay is stacked it does not heat up much and it remains green. The leaf will not have been lost, and the feeding value will be high. If tripods are used cocks may be made earlier, perhaps after one day, and a still better product will result. A field of old permanent pasture fertilized should give 30 cwt. of good hay with a feeding value of 1,500 lb. of starch equivalent per acre and 350 lb. of crude protein.

The protein in hay is not so digestible as the protein in fresh grass, dried grass or silage, but by making good hay we can make a considerable increase in our stocks of food for winter feeding.

Good haymaking alone cannot solve the problem of grass conservation, for we need a means of conserving grass at any time of the year ; and for this we must make dried grass or silage. But good haymaking is a means by which some of the grass of the spring flush can be conserved when we cannot dry it or make it into silage, because we have not the equipment to deal with the large amount of grass at that time of the year.

Lucerne is made into hay just like grass, but the leaf matter is very easily lost if the cock or tripod method is not used. Lucerne hay should contain 16–18 per cent of crude protein, but it is to be considered not as a concentrate but as a roughage with a high protein content, for its fibre content, though not much higher than that of grass, is less digestible.

The making of poor hay is not worth while. It is better to feed oat or barley straw than poor hay as a roughage, and it is cheaper and more convenient to do so.

What Kind of Drier ? There are several grass driers which can be bought in this country and several more which are in use in other countries. Whoever buys a grass drier nowadays should get one which he knows has been working successfully, not for a few hours but for a whole season ; and it should be a machine suitable for a farm and not only for a factory. There are several of them.

Most of them work with about the same fuel efficiency. They will evaporate about 7 cwt. of water for each hundredweight of coke used. Most of them will do a little better than this if they are well managed, and they will do worse if they are badly managed. Some require less labour than others for a given output. These generally have more moving parts and therefore the cost of maintenance and replacements is greater. Some have a higher initial cost but some compensating advantages.

The larger the output of a plant the lower the labour cost. Since fresh grass cannot be stored in a heap for more than a few hours, a continuous supply of grass must be brought from the fields for five or six months of the drying season, and this is more difficult with a big drier.

In this country, with its many systems of farming and with its large, medium and small farms, there is not likely to be any one size of drier which will suit all our conditions. We need a drier suitable for aerodromes, and in some cases one drier might be used for several aerodromes which can be treated as a group. The plant in this case will perhaps consist of one or more units, each with an output of 10–20 cwt. of dried grass per hour. The large farm generally has one or two units making 4-7 cwt. per hour. One of these units will be sufficient for the sixty to one hundred cow dairy farm, or the 200-acre all-grass farm.

Then there will be the plant to serve a number of small farms, or rather farms with a small area of grassland. This plant will probably be equipped like the large farm with one or more units making 4–7 cwt. per hour. And lastly, there is the small farmer with a plant of his own. This may be a one-man plant, making about 3–4 tons per week. The thermal efficiency is not appreciably lower than for the larger driers, and I believe this type of drier will be useful on many farms.

There may be other lines than those I have suggested, but I believe that our winter store of feedingstuffs can be increased by encouragement of the aerodrome drier, the farm drier, whether he be a large or a small farmer, and by communal driers.

Costs of Grass Drying I expect you would like to know what are the costs of grass drying. I used an I.C.I. Mark III drier this summer and, owing to the drought, I was only able to run the plant for twelve weeks instead of twenty, so there was a higher charge per ton for depreciation than there might have been. But the capital cost of this type of plant is lower than that of most driers, so the effect of depreciation is not so serious. As the summer was dry I was able to get a large output per week while I was running the plant, and this partly compensated for the effect on costs of the short season. My costs for drying alone, excluding the cost of the crop and bringing it to the drier, were £9 3s. per ton, and about 25 per cent of this was wages. If I had been able to work for twenty weeks instead of fifteen weeks, and the weather had been moderately dry, my costs would have been £8 5s. per ton. These costs do not include grinding the product or the cost of bags.

If the weather is very wet we get lots of grass, but there is more water to be dried off, and in a very wet week it may cost £12 per ton for drying and if the crop is very dry, when it is generally too mature and the dried grass is only of second quality, the cost may be down to £7 per ton for drying.

There is not much likelihood of improvements in the fuel consumption of grass driers, for they utilize 60–70 per cent of the heat generated by the fuel, and this compares well with a little over 80 per cent which is all that a large modern power station can do.

The cost of growing the crop to dry is a matter of ordinary farm costing which any farmer can do for himself. I consider that a crop of lucerne standing in the field is worth £5 for each ton of dry matter containing 20 per cent protein, that is, about £1 per ton of green lucerne standing in the field and reasonably near to the drying plant. A crop of grass yielding a product over 15 per cent protein would be worth the same amount. But these values only hold when the crop is just at the right stage of growth and the drier is available to dry it.

The cost of cutting, collecting and carrying the crop to the drying plant depends upon the equipment for and the organization of the work. The introduction of the green crop loader and the cutlift have been the most important developments in grass drying in recent years. They have made

it possible for two or three men to cut, collect, load and deliver to the grass drier 12 tons of green crop in eight hours, and they can be relied upon to do this every day. The total cost of dried lucerne and grass was for me about £18 per ton this year. This was without any addition for profit or interest on capital. In a good year it might have been £15, but I have no doubt that on many driers the costs were £21 per ton. Are dried grass and lucerne worth this?

Dried grass with 15 per cent crude protein has the same starch equivalent as oats, and its value, taking into account the high protein, the carotene and the as yet unexplained high value of leaf matter as a food, ought to make it worth 50 per cent more than oats, which is the only cereal crop we are permitted to grow for feeding cattle. With oats at £18 to £20 per ton, high protein dried grass and dried lucerne should be worth £27 to £30 per ton for feeding cattle.

SPRING CEREAL VARIETIES

RECOMMENDED LISTS

F. R. Horne, M.A., N.D.A., N.D.D. (Hons.)
Director, National Institute of Agricultural Botany

DURING the past thirty years the number of varieties of cereals offered to British farmers has been legion. Among these have been some which have given increased yields, higher resistance to disease or higher commercial quality. Others have led to an extension of successful cereal growing into new areas; some varieties, through ripening many days earlier, have enabled arable cropping to be pursued in districts formerly given up to permanent pasture of poor quality; yet other varieties have, owing to their stiff straw, proved suitable on the richest classes of land after such crops as potatoes, roots and vegetables.

During the First World War it became clear that many of the new varieties did not justify the claims made for them by their introducers, and both farmers and seedsmen recognized the necessity for properly conducted trials in all the principal cereal-growing districts. The National Institute of Agricultural Botany was established in 1919, with the principal object of classifying the varieties of arable crop plants and indicating those which are of particular value.

Early in the Second World War it was widely acknowledged that there were great advantages in reducing the numbers of varieties handled in the market. Growers found it easier to deal with only one or two varieties; seedsmen could more readily maintain stocks of seed at a high level of purity, and the processors were better able to offer well-graded produce at a reasonable price to the consumer.

For these reasons the Council of the National Institute of Agricultural Botany was requested, through its Seeds Production Committee, to prepare, on the basis of actual trials, a list of recommended varieties of winter wheat.

The original list was published in 1943,* and has been amended twice as valuable new introductions came forward and older varieties were superseded.

Requests for official recommendations covering other cereals led, in August, 1947, to the publication of lists of winter oat and winter barley varieties. In December, 1947, the range of barley, oat and wheat varieties was extended by the issue of Recommended Lists to cover spring sowing.

* Included in this Journal, September, 1944.

SPRING CEREAL VARIETIES: RECOMMENDED LIST

An explanatory note attached to these lists indicates that they embody the experience of the N.I.A.B. in trials conducted at representative centres in England; unless otherwise stated the recommendations do not necessarily apply to areas north of Yorkshire or to Wales.

SUMMARY OF RECOMMENDED VARIETIES

Spring Wheats	For mid-February to end-of-March sowings	*Atle* *Bersée* *Meteor**	*Not recommended for earlier sowing.
	For April sowing	*Fylgia* *April Bearded*† *Atle*‡	†When a bearded variety is required. ‡For highly fertile soils.
Spring Oats	For highly fertile soils	*Eagle* *S84*†	†For use when standing is of first importance.
	For soils of medium fertility	*Marvellous* *Onward* *Star* *Early Miller*† *Supreme*‡	†For use in Wales and Northern England. ‡For use when an early black oat is desired.
	For soils of medium to low fertility	*Golden Rain* *Victory*	
	For soils of very low fertility	*Black Tartarian*	
Spring Barleys	High malting quality varieties	*Plumage-Archer* *Spratt-Archer* *Earl** *Golden Archer*†	*For use when early ripening is essential. †Provisionally included.
	Stiff-strawed varieties of lower malting quality	*Kenia* *Maja*	
	Feeding variety	*Camton*‡	‡For use on very highly fertile land only.

Spring Wheat In the spring lists no reference is made to varieties bred for autumn sowing. Some of these, when sown before mid-February, are capable of ripening in time for harvest. Among English varieties, Yeoman, Holdfast, Squarehead's Master and Little Joss may be quoted as examples; it is commonly held in some districts that Little Joss is a true spring variety, but trials conducted throughout England have clearly indicated that it is dangerous to sow this variety after mid-February, because it may fail altogether to produce ears. Most of the French types of wheat, such as Vilmorin 27 and even Jubilégem, are able to ripen in reasonably good time when sown in January or early February. Dutch types of wheat, such as Wilhelmina, and Scandinavian types, such as Scandia, when sown after the normal autumn period, ripen too late for safe handling in most seasons, or may fail altogether to produce a crop of grain.

In the Recommended List, the true spring wheats are divided into two classes—those intended for early and late spring sowing respectively.

FOR MID-FEBRUARY TO END-OF-MARCH SOWINGS *Atle*, the result of a cross between Extra Kolben and a winter wheat, Saxo, has yielded consistently well in trials throughout Britain. Its stiff short straw makes it particularly suitable for richer soils, and its extremely high baking quality is attractive to millers. The rather sparse habit of growth of Atle is an advantage where grass seeds mixtures are sown. It is interesting to note that this variety has not been very successful in trials in its country of origin (Sweden)—a fact which illustrates the importance of thoroughly testing foreign varieties in Britain before they are either widely accepted or rejected.

Bersée is a very different type of wheat from Atle. Bred in France by Blondeau from a cross between Vilmorin 23 and Hybride des Allies (A.1), it is classed as "alternative," being suitable both for autumn and spring sowing. Although the straw is of medium length, it stands well. The grain is not popular with millers, in comparison with varieties such as Atle, but the yield is satisfactory. Bersée should not normally be sown after the end of March.

Meteor is a cross of April Bearded with Yeoman, which matures at a satisfactory date when sown late in March; it is included in the List provisionally.

FOR APRIL SOWING A covering note to the list of varieties for sowing in April indicates that wheat rarely gives as good yields as barley when sown after the end of March.

Fylgia, a cross of Extra Kolben with the early variety, Aurore, is included to meet the needs of late districts where exceptional earliness in ripening is of great value. The baking quality of Fylgia is considerably below that of Atle, but the strength of its straw is well above that of April Bearded.

April Bearded, an old established "land race" wheat, is provisionally recommended for late sowing where a bearded variety is required. Its long straw makes this variety unsuitable except for land of moderate fertility.

Atle has given much lower yields on average soils when sown after the end of March. Nevertheless, on account of its extreme stiffness of straw, Atle may still be the best variety for sowing during April on highly fertile land; it has therefore been provisionally included in the List for April sowing.

Spring Oats The diversity of uses for oat crops makes it necessary to prepare lists covering four ranges of fertility.

Growers of varieties for sale are unanimous in regarding consistency in yield of grain as the first essential. Yielding capacity is, however, not a simple affair, and those varieties which yield best on fertile land may give very low outputs on poorer soils. In some cases the varieties with tall straw are potentially the highest yielding, but the fact that they lodge under fertile conditions places them at a disadvantage beside stiff-strawed types. On account of the extension of ley farming systems and the wider use of nitrogenous manures, more and more farmers are seeking varieties of oats with greater strength of straw than those previously grown. Tillering capacity, i.e., the ability of the plant to produce side shoots, illustrates the need to use different varieties under varying conditions of fertility. For soils of high fertility, low tillering capacity may be an advantage, while for the poorest soils good tillering ability is an essential feature in oat varieties.

In the past, growers of oats for sale have tended to attach less importance to thinness of husk than to the boldness of the sample. While reasonable uniformity in size is an undoubted advantage to the oatmeal miller, buyers are now paying much closer attention than formerly to the actual percentage of husk.

For those growing oats primarily to feed on the farm, a high percentage of kernel is just as important as high yield. For home feeding, some variation in size is not a disqualification. On farms where there is a big head of cattle in relation to the acreage of arable land, the yield of oat straw is important, and on land of medium or low fertility this is another reason against the growing of varieties with the shortest straw.

VARIETIES FOR HIGHLY FERTILE SOIL *Eagle*, a cross between Victory and Von Lockow's Yellow, has given higher yields in trials than Victory, while its straw is less liable to lodge. The grain is rather small, but the husk is thinner than that of Victory, making it very suitable for home feeding. Eagle shows marked resistance to frit fly attack.

Aberystwyth S84 is a cross between Victory and Red Algerian, with even stiffer straw than Eagle. In trials south of the Humber it has yielded slightly less than Victory and ripened rather later; it is valued chiefly for conditions where standing is of first importance.

VARIETIES FOR SOILS OF MEDIUM FERTILITY *Marvellous*, a hybrid introduced by Messrs. Gartons, has stout, stiff straw. It is suitable for use on moderately fertile land provided it can be sown not later than February. Both grain and straw are rather coarse.

Onward was selected by Messrs. Gartons from a cross between Marvellous and Superb. This variety matures very early and gives high yields of short, plump grain with a thick husk. The straw, though fairly stout, is inclined to brittleness if allowed to become over-ripe.

Star is the result of a cross made at Svalof between Victory and Crown. This variety has the advantage over its Victory parent of a thinner husk and better standing straw. Under many conditions it can, with advantage, be grown instead of Victory.

Early Miller is a selection from a cross of Potato with Record made by the Scottish Plant Breeding Society. This variety is provisionally

included with a recommendation for use in Wales and Northern England. In these areas it matures slightly earlier than Victory, has a stiffer straw and an equally good yield of grain.

Supreme, a black-grained oat resulting from a cross made by Messrs. Gartons between Bountiful and Abundance. It has a short, stiff straw and its early maturity has distinct value in later districts. This variety is provisionally included in the Recommended List because it appears to be the best black oat variety.

VARIETIES FOR SOILS OF MEDIUM TO LOW FERTILITY

Both *Golden Rain* and *Golden Rain II* (a cross of Golden Rain with Victory selected at Svalof) have given similar yields of grain and straw to those of Victory. The grain, though small and yellow, has a rather lower percentage of husk than Victory, while its straw is stronger.

Victory. This very well-known variety was, like Golden Rain, the product of pure line selection at Svalof from the old mixed variety, Probsteier. It may still be regarded as a reliable variety for average soils on which lodging is unlikely to take place.

VARIETIES FOR SOILS OF VERY LOW FERTILITY

Black Tartarian is an old variety introduced from Southern Europe. The straw is long and the grain black with a high proportion of husk. It is very late in coming to harvest. On all but the poorest soils Black Tartarian could, with advantage, be replaced by one of the above varieties.

Spring Barley

Although a formal Recommended List has not previously been published, selective buying and the recommendations from official yield trials conducted since 1924 have led to the establishment of Spratt-Archer and Plumage-Archer over more than two-thirds of the barley acreage of England.

HIGH MALTING QUALITY VARIETIES

Plumage-Archer. The original introduction was the result of a cross between Plumage and Archer. This variety has erect, broad ears with a very short neck which does not "kink" like its parent, Plumage. The straw is moderately short and stands fairly well. It is earlier in ripening than its parent, Plumage. It gives good yields on the more fertile soils; the grain is of high malting quality and in special demand in some districts on account of its large size.

Spratt-Archer. Although the result of a cross between Archer and Spratt, this variety closely resembles the original Archer. It is, however, earlier in maturity, stiffer in straw, higher yielding and of extremely high malting quality. Spratt-Archer tillers very freely and stands fairly well. Its yielding capacity, especially on lighter soils, is usually slightly greater than Plumage-Archer.

Although Spratt-Archer suffered the most severely in the barley disorder which was widespread in eastern England in 1947, there is no reason to believe that this was due to any weakness in this variety.

Earl, a selection by Dr. Hunter from Spratt-Archer, is quite distinct in its period of maturity, ripening 7–10 days earlier than the parent variety. In yield and quality of grain it closely resembles Spratt-Archer. This variety is provisionally recommended for regions where a combination of high malting quality with early ripening is required.

Golden Archer is the result of a cross made by Dr. E. S. Beaven between Plumage-Archer and Spratt-Archer which closely resembles its narrow ear parent. In certain districts Golden Archer frequently displays very high malting quality, and it is therefore provisionally included in the List. In most districts Spratt-Archer gives rather better results.

STIFF-STRAW VARIETIES OF LOWER MALTING QUALITY

Kenia was selected at the Abed Station in Denmark from a cross between Binder and Gold. On account of its short, stiff straw, it is adapted for the more fertile barley soils. Its extreme earliness in ripening enables it to be harvested well before Plumage-Archer or Spratt-Archer. The yielding capacity on moderate soils is usually below Spratt-Archer, but its greater resistance to lodging makes it suitable for conditions where the highest malting quality is not expected.

Maja was selected from the same cross as Kenia and resembles this variety very closely both in appearance and in agricultural value. The yield may, under certain conditions, be slightly higher, but the strength of straw is not quite so good as Kenia.

FEEDING VARIETY

Camton, the result of a cross between Spratt and Archer-Goldthorpe, has very short, stiff straw. Its use is limited to highly fertile soils where resistance to lodging is the first essential. Camton is unsuitable for malting, but it can well be included with oat varieties in dredge corn mixtures.

References

1. Varieties of Cereals for Spring Sowing. *N.I.A.B. Farmers' Leaflets No.* 2. (*Revised December*, 1947).
2. Spring Oat Trials, 1932-1935. E. G. THOMPSON. *Journ. N.I.A.B.*, **4**, 127-43.
3. County Spring Oat Trials. B. BRANDRETH. *Journ. N.I.A.B.*, **4**, 144-6.
4. Trials of the Spring Oats. E. G. THOMPSON *Journ. N.I.A.B.*, **4**, (1939) 389-99.
5. Yield Trials, Spring-Sown Barleys, 1933-1937. E. G. THOMPSON. *Journ. N.I.A.B.*, **4**, 275-86.
6. A Disorder of Barley Ears in East Anglia, 1947. W. A. R. DILLON WESTON, E. C. LARGE and F. EARNSHAW. *Jour. Min. Agric.*, **54**, (December, 1947) 417.

British Council Conference Grant

The British Council has for some time had a small fund from which grants have been made in exceptional cases to permit the attendance of foreign scientists (including agriculturists, engineers and medical men) at national or international conferences or meetings held in the United Kingdom.

The principal grounds upon which such grants have been made are (a) that the application has been received from the body convening the conference or meeting, (b) that the Science Committee of the British Council has supported the application, (c) that the foreign visitor would be unable to attend without assistance.

The grants cover subsistence or part-subsistence in the United Kingdom during the period of the conference or meeting. Fares to and from the United Kingdom, are not included. No grants are made in respect of secretarial or other organizing expenses, or for entertainment of delegates or hire of premises.

Conveners of conferences or meetings to be held in the fiscal year 1948-49 are advised that it is necessary that applications for assistance to foreign visitors should be received not later than January 31, 1948. All applications will be considered together, and conveners will be notified of the results by the end of February, 1948. It is improbable that more than a small proportion of applications can be met from the fund.

Applications with full particulars (including reasons why financial support is considered necessary) should be addressed to the Administrator, Science Group, British Council, 3 Hanover Street, London, W.1.

MILK AND BEEF

TWO ASPECTS OF A BREEDING AND REARING POLICY

JOHN HAMMOND, M.A., D.Sc., F.R.S.
School of Agriculture, Cambridge

BREEDING for milk is a difficult undertaking but for three reasons it is worth while. First, fresh milk has to face no competition from abroad and there is, therefore, a degree of certainty about the future market. Secondly, though consumption of milk has increased during the last few years, consumption per person is still far below that in the U.S.A. and Canada. Medical opinion throughout the country is strongly in favour of a higher milk consumption, and it is reasonable to assume that a further increase in production is necessary before the public demand will be fulfilled.

The third reason is that from the viewpoint of food conversion it is a sound economic proposition. The dairy cow converts food more efficiently than any other animal; compared with beef, the protein conversion efficiency is twice as high. In this respect, however, there is a great difference between a good and a bad cow. For example, in the case of a 320-gallon cow, 56 per cent of the food is necessary to keep the animal alive, and only 44 per cent is converted into milk, whereas with an 850-gallon cow the figures are 35 per cent and 65 per cent respectively. As the yield goes up the profits for a given quantity of food will go up. There is, therefore, every reason why an effort should be made to improve the milking qualities of dairy cows.

More Milk by Grading Up In my opinion the best way to do this is to grade up the herds by mating with a well-bred dairy bull of a high genetic milking capacity. For instance, a 320-gallon cow mated with a bull at the 1,000-gallon level will give a 650-gallon cow in the first generation and an 800-gallon cow in the next generation. By using three good bulls in succession it is possible to grade up to a 50 per cent, 75 per cent and 87½ per cent pedigree, high-yielding herd in successive generations. This is a far cheaper method than culling all the bad milkers and bringing in good young heifers. Such a policy would send up the price of heifers and involve the dairy industry in a heavy capital expenditure. But grading up by using a good bull does not involve a great money outlay, especially in these days of artificial insemination. Obviously, diseased animals should be culled. In grading up, you must decide on one breed and continue to use good bulls of that breed; and once the policy has been settled, it must be pursued persistently.

Traditionally this country has been beef and not milk producing, and we are now suffering because of that. In the past the breeders of dairy cows have copied the methods of the beef breeders. For meat production many breeders like a first cross. In the first cross the best characteristics of both sides appear and the bad characters are hidden. Continued breeding from these, however, brings to light the hidden bad characteristics. The beef breeder is able to market all his first crosses to the slaughterhouse, but the dairy breeder has to continue breeding from his first crosses in order to maintain his herd numbers. Many poor quality herds today are the direct result of this. If breeders will make up their mind which breed will suit their particular purpose and continue to use good bulls of that breed, then they can rest assured that they will be producing economical cattle and increasing the capital value of the herd.

The policy should be to grade up to a bull of the 1,000-gallon level. The production of such bulls is the concern of our pedigree breeders. In the management of a herd it is much simpler if all the animals breed at about

the same level. Whether we have a 1,000-gallon level or an 800-gallon level, the important thing is to aim at uniformity. It takes six years to prove a bull—that is, to find out how his daughters milk. In future we must look to the old proven bulls as the source from which to get young bulls. The policy of using a proven bull as a basis for all breeding for milk has been used in Denmark since 1900, with the result that the average production per cow has been raised from 6,500 lb. to 8,500 lb. Judging by National Milk Records, the average milk production in England and Wales (which now varies between 6,225 lb. for South Wales and 7,738 lb., for the eastern region of England, and averages 7,132 lb.) is not far off the Danish average for 1900. Denmark has poor soil, and we ought, therefore, to do much better here.

Careful Selection of the Bull It should be the aim of dairy breeders to breed bulls with a guarantee of breeding at a high level, and the commercial producer should use those bulls. The ideal, of course, is to take the son of a proven sire out of a cow with a long, lifetime record of high milk yield. Today many bulls are sold on the record of some remote female ancestor, and the odds are very much against their breeding true for milk. In choosing a bull, therefore, before you can get the odds in your favour, some knowledge of the breeding qualities of the males in the pedigree is necessary. In the past the trouble was that the records went only as far as the dam of the bull. If you know that the bull is from a proven sire and out of a good dam, then the odds are in your favour. Many persons think that they can judge a bull merely by looking at it, and they often argue that because it is not beef it must be milk ! This idea is entirely wrong ; it is essential to study the animal's record as well as judging it by appearance.

One difficulty here is that bulls do not live long enough. Few dairy bulls are kept until they reach the age of six years ; generally most of them are disposed of at 2½ to 3 years, and it is therefore impossible to determine their milking quality. Every year in this country 36,000 bulls are licensed but only 18,000 bull calves are registered in the breed herd books, which suggests very strongly that there must be a large number of inferior bulls, without any ancestry of milk records, being used.

Another difficulty is the very high percentage of small herds (fifteen cows and under) in the country. In these herds it is uneconomic to keep a bull at all, let alone a good one. As a result there is indiscriminate crossing. The solution to this problem is artificial insemination. It will soon be possible for practically every farmer in the country to make use of artificial insemination stations.

Better Breeding means Cheaper Milk Finally, there is a large amount of wastage in dairy herds—about 20 per cent per year. The average cow goes out of the herd when she is about 5½ years old, and that means that the average cow never comes to full milk yield, which is attained at 7½ years old. This is due largely to diseases and to the fact that the bulls we are using at present are not breeding true for high milk production. If the average herd life can be prolonged milk will be produced much more cheaply. Feedingstuffs account for almost half the cost of milk production. Because of the high overhead food costs of rearing a heifer to milking age, and her low production in her first year, the food costs per gallon of milk produced are twice as much if she leaves the herd at 5½ years old as if she remained in it until 7½ years old. A large reduction in the cost of milk production is therefore possible by better breeding and by controlling disease.

More Milk, More Beef With regard to beef, there is a big difference between the pedigree breeders and the commercial producers. While the method of rearing one calf to one cow is justifiable for pedigree breeders with bull calves to sell, for commercial producers it is very uneconomical unless they are on very poor land. By the use of hormones, twins and triplets can now be produced, but at present this difficult process is only in the experimental stage. An attempt should be made, however, to breed a strain of beef cows which produces twins, as sheep do.

Increased efficiency in breeding for milk can be used to increase the efficiency of commercial beef production. There is no reason why a cow yielding 900 gallons should not rear nine calves, each calf receiving one gallon per day. Rearing on the bucket is a costly method. A cow yielding 3 gallons per day can suckle three calves for 100 days, and then another three or less (according to the daily yield) can be put on. The cow can graze with the dairy herd by day and come in to the calves in a box at milking times. By keeping the calves indoors, they can be given concentrates and so be weaned without setback. However, whatever method of rearing is adopted, the system of one calf to one cow should definitely be abandoned as a very uneconomical procedure in commercial beef production. Before the war the consumption of meat (beef, mutton and pork) was approximately 140 lb. per head per year; today it is under 100 lb., due largely to decreases in home production.

Up to the present the increase in milk production has been obtained largely by increasing the number of dairy cows. The time has now come when extra milk should be produced by better breeding and management and the control of diseases. This would provide an opportunity for rearing more cattle for beef. Dairy cows that have already paid for their keep in milk production, and from which dairy heifer replacements are not required, could be mated with a good beef bull. The result would be an animal only slightly inferior to a pure beef animal. For this purpose bulls of colour-marked breeds, that is, breeds such as the Hereford and Aberdeen Angus which pass on their colour to their calves, should be used (colour-marked calves do not get mixed with dairy-bred calves in the markets).

This system cannot be carried out without the help of artificial insemination because the average dairy farmer, with herds of fifteen or under, will not be able to keep two bulls. If beef bulls were kept at artificial insemination centres a farmer could mate his best milking cows (from which he required replacements) to a dairy bull, while the poor milkers could be mated to a beef bull and would supply calves of higher value for sale for beef purposes.

THE MILKING SHORTHORN IN AUSTRALIA

John Green

In Australia a few years ago three distinct branches of the Shorthorn family were competing in the milk business. There was the Australian Illawarra Shorthorn, the Milking Shorthorn, and the Dairy Shorthorn of Coates's Herd Book. The two former breeds derived from New South Wales, where the Illawarra district is situated, and from where the infant Sydney drew its first milk in the uproarious pioneer days of last century. The South Coast district, so rich in contrast to the inhospitable bush surrounding the port of Sydney, in effect occupied a relationship like that of Ayrshire and Renfrewshire to the growing Glasgow. Nowra at the mouth of the Shoalhaven River was the Kilmarnock of early New South Wales. Thus the ancestry of the Illawarra Shorthorn goes back to the cows that stepped ashore from the first sailing ships. They were animals of mixed breed, principally Durhams but also Ayrshires and Devons, no doubt depending on the ship's port of embarkation. It is with justifiable pride that the Illawarra cattle claim a consistent breed policy since the close of the eighteenth century, adding to the rigours of seamanship and acclimatization, the constant test of liquid milk production for the largest urban centre in the southern hemisphere. The south coast is also one of the most "tightly held" in Australia, and the Illawarra cattle have long been passed as heirlooms throughout this sound and conservative farming district.

The Result of Pioneer Breeding The present Australian Illawarra Shorthorn is lighter in bone than our own Dairy Shorthorns, particularly at the shoulder and fore-end. The udder is capacious but not invariably faultless. The head is somewhat longer and less elegant. The colour is predominantly red, which some people attribute to their Devon blood, and roans on the coast are certainly an exception to the rule. If the Australian Illawarra seems light by our standards one cannot deny that it is a rational milking cow, and only this year when I saw the cream of the breed paraded within sound of the Pacific breakers on Kiama Show-ground, no other breed, including the Friesian, Ayrshire and Jersey, could steal their limelight. All this is a tribute to the pioneer breeders of the South Coast and to the work which families like the Greys, Dudgeons and Chitticks are still putting into the breed.

The Milking Shorthorn also hailed from the South Coast, but by contrast was reputed to have been pure Durham; although its lineage is also lost. These cattle are heavier and more inclined to the conventional roan colouring of our own Dairy Shorthorns. From this breed was produced Melba XV who in 1923 established the world's butterfat record of 1,614 pounds of butter in 32,522 lb. of milk, an average of 5 per cent. The milking life of Melba XV of Darbalara is still worth recalling.

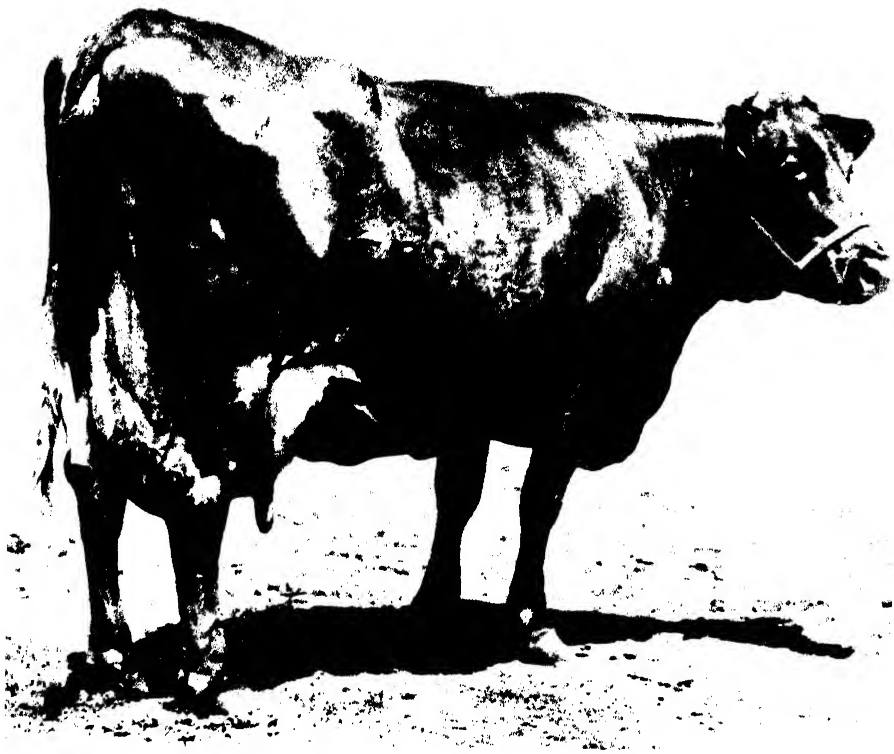
Commencement Date	Age	Period of Test	Milk	Test	Butter Fat
			lb.		*lb.*
20.2.1918	2 yr. 5 mth.	273	8,844	4.5	395.073
18.3.1919	3 ,, 6 ,,	273	13,510½	4.3	587.13
9.5.1920	4 ,, 8 ,,	273	18,131¼	4.3	773.30
		365	21,635½	4.4	954.47
17.2.1922	6 ,, 5 ,,	273	22,597½	4.4	988.17
		365	29,432	4.5	1316.81
4.7.1923	7 ,, 9 ,,	273	26,863½	5	1292.32
		365	32,522½		1614.1

Illawarra and Milking Shorthorn Breeds Combined A few years ago the Australian Illawarra Shorthorn Society absorbed the remnants of the Milking Shorthorn Breed, and thereby hangs a tale. One need only add by way of greater clarity that the Coates's Shorthorn has always been confined to Victoria, where, in a less variable Mediterranean climate, the Victorian breeders have introduced and followed the fashionable Coates's lines. Except for their grading-up herds they have no connection with the "dinkum" Australian Shorthorns of the South Coast.

The fame of the Milking Shorthorn centred round the Darbalara herd. Darbalara Station is inland near Gundagai, in the area of higher temperatures and lower rainfall. The forebears and descendants of Melba XV were therefore reared on strong unleached soils, where they would rely on lucerne and imported proteins for their performances. When Mr. Cole, the late manager of Darbalara, was alive, he resisted any amalgamation of the two New South Wales breeds. Rightly or wrongly he regarded the Milking Shorthorn as superior in milking capacity and constitution to its cousins of the Illawarra district. When, after his death, the amalgamation of the two breeds finally occurred, the Darbalara blood became represented principally in two herds. The first belonged to the Plashett Pastoral Company, whose owner also acquired the services of the head stockman (Mr. Costello) who had fed the early record breakers, including Melba XV. Plashett is a beautiful property on the fringe of the Hunter River Valley (also the nursery of the Australian thoroughbred) and enjoys a climate a little more similar to that of Darbalara. The second herd was back again in the heart of the South Coast district at the New South Wales Government's Boys' Welfare Farm at Berry. Today these two herds hold the principal representatives of the Darbalara families, and it is not without significance that in 1939 the Plashett cattle dominated the Australian Illawarra Shorthorn Lactation competition, with the Berry cattle in the fourth place. It is equally noteworthy that neither they nor any other exhibitors of the Darbalara type can gain a foot-hold in the show-ring against the lighter Illawarra cattle. The result of this is twofold: there is a strong tendency on the part of the old Milking Shorthorns to look disconsolately towards Coates's Herd Book and to be a little suspicious of their new alliance, while the Australian Illawarra Shorthorn Society at the same time strengthens its determination to absorb them into Australia's national dairy breed.

The following were the records of the winning Plashett team of seven cows in the Illawarra Shorthorn Lactation competition in 1939. They are as much of interest as an indication of what dairy cattle in Australia can achieve as they are a reminder of the continued performance of the old Milking Shorthorn families, not only in quantity of yield but also in butter fat.

		Age	Milk lb.	Test	B.F.	Days
Plashett	Bertha 4th	9 yr. 11 mth.	15,323	4.2	636.8	213
,,	Kate 13th	4 ,, 11 ,,	12,981	4.9	638.2	,,
,,	Pearlie 7th	8 ,, 0 ,,	23,214	4.6	1056.4	,,
,,	Pride 15th	4 ,, 11 ,,	15,538	4.0	625.9	,,
,,	Kate 15th	10 ,, 5 ,,	18,867	4.9	966.7	,,
,,	Lincoln 16th	6 ,, 11 ,,	20,923	4.2	897.4	,,
,,	Kate 15th	2 ,, 2 ,,	12,162	4.2	511.4	,,



Melba 15th of Darbalara

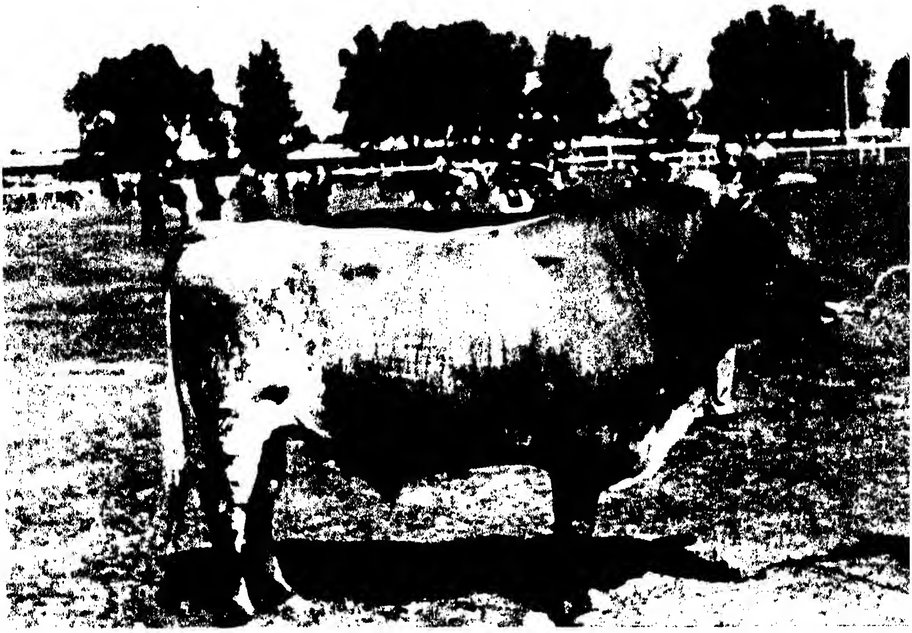
Holder of world's butterfat record (192[illegible])
with 32,522½ lb. of milk @ 5 per cent.

Plashett Pearlie 7th

Leading cow in the Australian Illawarra Shorthorn Lactation Competition, 1939. Gave 23,214 lb. of milk @ 4.6 per cent. Note Darbalara type well preserved.

Plashett Lincoln 47th

Shows dual-purpose type.



Kingstone of Braeside

Born March 2[illegible], 192[illegible]. A great-great-grandson of Melba 15th. He has Melba 15th's sire on both sides of his pedigree.

Plashett Royal Command

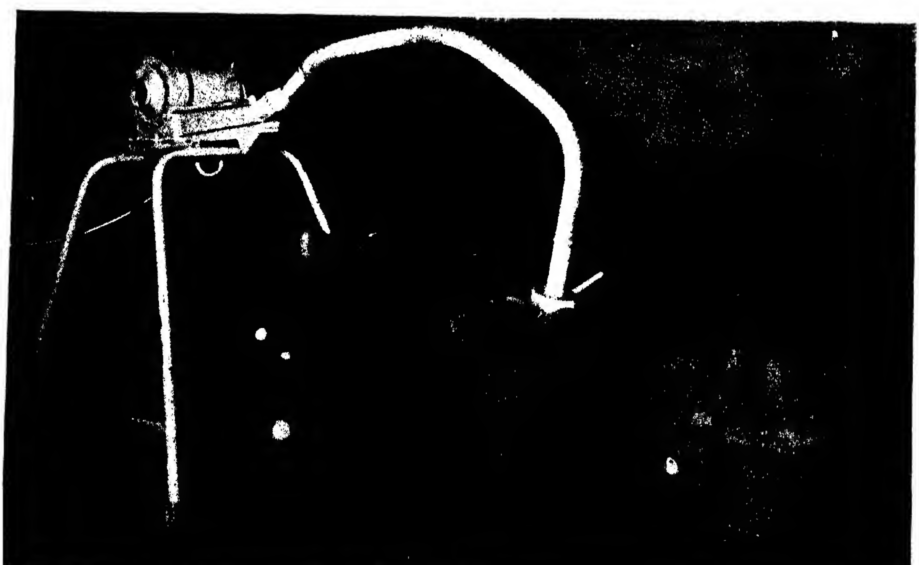
Showing dual-purpose type.

ARTIFICIAL DRYING OF VEGETABLE AND HERBAGE SEEDS

(See pp. 462-66)

The Spear Conditioner

Sheaths of different size perforation are required for varying types of seed, i.e., small seed requires small perforation. (*Left:* Sheath easily inserted with rammer)



Photos, *Farmers' Weekly*

Complete unit in operation

Grading Up at Willow Park, Victoria The most interesting comment on the present situation is the opinion of Mr. W. K. Atkinson of Willow Park, perhaps the leading breeder of Dairy Shorthorns in Victoria, and an upholder of the Cumbrian tradition in the New World. The sun-grilled irrigated pastures of the Murray River have not diminished his belief that anywhere in the world a dairy cow can be as big as she is good. Mr. Atkinson went to Australia with his family as a young man in 1910 (and incidentally retains among his souvenirs Ruskin's signature, and recalls as a boy taking the critic in a boat on Coniston). As a young settler with his way to make, he had little capital with which to start farming. He therefore had to grade up to his present valuable herd from whatever cattle he was able to secure in Australia which would conform to his dual-purpose ideal. It was natural that he should find these chiefly among cattle of the Darbalara type within the Milking Shorthorn breed. Following the methods of Bates, he used one bull, Havelock of Darbalara and his sons, and introduced no new blood for eighteen years. Havelock, who died as a result of an accident when thirteen years of age, was a maternal half-brother to the sire and dam of Melba XV, and as if to dispel any suggestion of chance in his offspring, became a proven sire by accepted standards. He is the only bull in Victoria to have sired four daughters whose lifetime records exceeded a hundred thousand pounds of milk and/or five thousand pounds of butter. The record of these four daughters of Havelock were as follows:

NAME	AGE	AVERAGE YIELDS			LIFETIME YIELDS UNDER TEST	
		Milk	Test	Fat	Milk	B.F.
	yr.	*lb.*	*per cent*	*lb.*	*lb.*	*lb.*
Willow Park Cheery	10	15,188	3.94	599	151,880	5,990
Willow Park Moss Rose	9	12,204	4.09	500	109,839	4,498
Willow Park Blush	12	11,398	3.94	449	135,266	5,388
Willow Park Damsel	10	10,242	4.26	437	102,420	4,370

In addition, the equal parent index of Havelock is also interesting:

	No. of pairs	Records Studied	(Age corrected yields) Milk	Test	B.F.
			lb.	*per cent*	
Dams	22	108	8,888	3.95	350
Daughters	22	127	9,455	4.13	391
Difference in Average Yield			567	.18	41
Sire's Index			10,022	4.31	432

It was only when inbreeding was no longer safe, and the performance and appearance of his herd beyond doubt, that Mr. Atkinson, then a middle-aged man, began the laborious process of grading up into Coates's Herd Book. He boldly imported Wicklesham Lord Barrington V. Since then he has used Anderson Imperial Cran VI (Imp) and only this spring secured from Messrs. Ashton and Hibberd, Scotsgrove Hero XV. The relevant thing is that while the daughters of these imported English bulls have given as great quantities of milk, the butterfat percentages have declined.

For example, in 1935–36, at the end of the Havelock regime, the Willow Park herd averaged 4.16 per cent of butter fat in 9,490 lb. of milk. Whereas in 1944–45, after using the first two Dairy Shorthorn bulls, it averaged

3.54 per cent in 9,065 lb. The butterfat percentage of the pure-bred Australian Illawarra is also closer to our own Dairy Shorthorn figures, although, as in this country, several of the leading breeders are now working to improve their butter fats.

Could we use the Darbalara Females in Britain ? The question that presents itself from these facts is whether the Australian Shorthorns generally have any outstanding merit as dairy animals. Breeders in this country will naturally follow the fate of the cattle in the Coates's Herd Book with interest, and there are already good Dairy Shorthorns in Australia. I suggest, too, that the Illawarra Shorthorn is a breed of virtue, whose development and performance should not be beneath our notice. However, I am still more convinced—and a real champion of the Dairy Shorthorn, Mr. Atkinson, has shared for years in isolation this same conviction—that the Darbalara cattle had unusual merits. If there is any chance that their performance has a genetic foundation it should be investigated. As things are at present, they must in a few years become dissipated throughout the Dairy Shorthorn family in Victoria or the larger Australian Illawarra breed in New South Wales and Queensland. It is my belief that females of the old families might advantageously be graded up into the Coates's Herd Book in this country. We could at least do as well as Mr. Atkinson, and with our best butterfat sires we might do better and improve our Dairy Shorthorn butterfat performance.

ARTIFICIAL DRYING OF VEGETABLE AND HERBAGE SEEDS

C. North, B.Sc. (Hort.)
National Institute of Agricultural Botany, Cambridge

THE majority of seed driers in this country have been designed for conditioning grain, but many of them can be used for drying vegetable and herbage seeds or may be made suitable for this purpose by simple modifications. Although seed has been conditioned by infra-red radiation, air dessicated by chemicals and air under reduced pressure, seed drying by means of a draught of warm air remains the most economical for general use. A vacuum drying plant that will condition seed has been designed in Sweden, and a similar plant is now being produced in Britain. This machine dries seed safely and uniformly, but its high price puts it out of reach of all but the largest establishments.

The Hop Kiln Hop kilns are not suitable for drying seeds of all species, for the up current of warm air is rarely strong enough to force its way through a layer of seed and maintain sufficient airflow. It is essential to dry small seeds in bags or on hessian spread over the drying floor, and both these precautions further reduce the airflow. Quantities of seed which do not entirely cover the drying floor cannot be satisfactorily conditioned, for most of the warm air then escapes through the uncovered floor space and does not assist in drying.

A number of seed crops such as onion, leek, cauliflower, and occasionally grasses and clovers, are dried in the straw, and for this purpose a hop kiln is particularly suitable. The material may be stacked 4 feet high on the drying floor and offers little resistance to the passage of the air.

Bag Driers The bag drier is the oldest type designed specifically for the conditioning of seed. About one hundred and ten "bag driers" were in use in Scandinavia before 1919, by which time the system had been patented as the "System Dinesen" by J. Krüger of Copenhagen. A number of similar plants erected in this country have given good service for over twenty years.

The essential feature of this type of drier is that the seed remains in the bag whilst drying, and the risk of contamination of different lots is therefore negligible. Beds of concrete or wood are constructed to take one or more sacks laid lengthwise; the best type has wooden frames about 3 × 2 feet for individual sacks. Thick West of England type sacks are best replaced by those of more open texture whilst drying. Sufficient seed is added to a sack to form a layer no more than 9 inches deep over the drying bed, and the bags are turned once during conditioning to ensure an evenly dried batch. If the drier has no provision for changing over rapidly to cold air, the sacks should be opened and allowed to cool as quickly as possible after removal from the drying beds.

The efficiency of the fan producing the air draught has deteriorated through wear and tear in some bag driers. Whether or not the fan requires attention can be determined by laying a handkerchief on a bag of seed being dried; if the fan is in good order the handkerchief will billow up in the air passing through the bag of seed.

Bag driers require more labour than the mechanical types to keep them running, but their initial cost is comparatively low and no lengthy cleaning is necessary to prevent contamination of seed stocks through mixing during drynig.

The Spear Conditioner This small drier has recently come on the market. It is a light machine which can be transported with ease, and is used to dry one sack of seed at a time. A perforated metal sheath is rammed into the centre of the bag of seed to be dried, and through this thermostatically controlled warm air is blown. The machine is entirely dependent on an electricity supply for its heating and air draught, but it will work off the ordinary household supply voltage and consumes rather less than 20 amps. Whilst it cannot compete with the larger types of drier for throughput, this machine is particularly suitable for dealing with small quantities of all types of seed.

Stationary Tray Driers This type, consisting of a tray with a perforated or slatted drying floor through which air is blown, is the simplest in design of all driers. Most grass driers work on this principle and are suitable for drying seed if the temperature of the drying air can be accurately controlled. A stationary tray drier is suitable for treating all types of seed, both threshed and in the straw, and can also be used as a bag drier. It is cheap and easy to construct but requires much labour to work and does not always provide a uniformly dried sample.

When building a tray drier a mixing chamber about a yard high should be constructed underneath the drying floor to ensure good distribution of the air, and for the same reason baffles can be built in the mixing chamber if necessary. The drying floor itself is usually constructed of perforated

metal sheeting strengthened by brick or metal supports. Provision should be made for an airflow through the tray, of about 50 feet per minute, maintaining a pressure of approximately one inch of mercury underneath the tray. The power required to provide the airflow will depend upon the type of fan, its size, and the speed at which it is designed to work. An approximate figure can, however, be obtained by allowing one horse-power for every 30 square feet of the drying floor.

If the tray drier is to be used for drying grain as well as other seeds it is an advantage to have the floor at an angle of about one in ten. Seeds can then be loaded on the tray at the highest end and raked down to a chute for bagging off at the lower end when dry. It is important to maintain a uniform layer of seed so that the batch may dry as uniformly as possible, and for this purpose a two-pronged wooden rake is a useful tool. The seed layer should never be more than 6 inches deep.

When very small seed is dried it will be necessary to line the tray with hessian. A lining of hessian is also the best way of preventing the contamination of stocks through mixing, for the tray drier is not easy to clean thoroughly. An ordinary domestic vacuum-cleaner will be found useful for removing seeds wedged in the corners of the drying tray and in the perforations of the floor.

Mechanical Tray Driers These driers are the most suitable types when moderate to large quantities of a variety of seeds have to be conditioned. They can be used as bag driers, and as stationary tray driers to treat seed in the straw.

There is considerable variation in the design of the different makes of mechanical tray driers, some having perforated, and others slatted, drying floors. In some makes the progress of the seed is effected by two chains fitted with cross pieces which move slowly down the tray. Others consist of a number of small units, the seed being moved from one end of the drier to the other by a jerking movement of the trays or by gravity.

When purchasing a mechanical tray drier for treating a variety of seed directly on the tray, it is important to choose one which can be cleaned quickly and easily, for this process may take from ten minutes to three hours, according to the make of drier.

Vertical Grain Driers These were designed mainly to "keep pace with the combine." Generally speaking, they are cheaper than the mechanical tray driers and often more economical to run, but they are useful only for treating a strictly limited variety of seed. Most large seeds such as beans, peas, beet and mangold can be successfully conditioned in large quantities in the majority of vertical grain driers. Some driers of this type can be adapted to treat small seed by lining the drying chambers with hessian sleeves.

Air Temperature The maximum temperature to which seed may be raised without damage to the germ depends upon the moisture content of the seed, and to a less extent the time during which it is subjected to that temperature. Seed with a low moisture content will tolerate a higher temperature than that with a high moisture content. For this reason it is advisable to start drying at a low temperature and gradually raise the temperature as the seed loses its moisture.

Very little experimental work to determine the critical temperature for the drying of different kinds of seeds appears to have been carried out. Table 1 sets out the limits generally accepted in practice.

Table 1. Maximum Temperature of the Air in which Certain Kinds of Seeds may be Safely Dried

Kind of Seed	Temperature (*Degrees F.*) (1)	
	Normal Sample (2)	Very Wet Sample (3)
Beans, onion, leek.	90	70
Brassicas, peas, clovers, timothy, linseed, mustard.	100	80
Cocksfoot, ryegrasses, mangold, beets.	120	90

Note. (1) Temperature of the air as it comes into contact with the seed.
(2) Moisture content no more than 8 per cent above that recommended for safe storage in bags (see Table 2).
(3) Moisture content higher than 8 per cent above that recommended for safe storage in bags (see Table 2).

It is important to ensure that the air temperature is accurately controlled, and where there is any doubt that it can be maintained to the nearest ten degrees Fahrenheit it is wise to keep to temperatures ten degrees below those recommended above.

After drying, the seed should be cooled as rapidly as possible by a draught of cold air or by spreading it out in a thin layer. Seed adjusts its moisture content according to the temperature and humidity of the surrounding air, and the normal moisture content of the seed rises as the temperature gets higher. Thus heated seed, if left to stand without cooling rapidly, will absorb moisture from the atmosphere.

Moisture Content of Seed for Storage Under average conditions seed stored in bags will gradually adjust its moisture content to the normal "air dry" moisture content, a figure for which is given for a number of seeds in the Ministry of Agriculture's Bulletin No. 130, *Threshing of Grass Root and Vegetable Seed Crops.** The question that therefore arises is: How wet can seed be bagged for storage without inducing a too rapid loss of vitality? Generally speaking, for this purpose seed may contain 2–2½ per cent of moisture above the normal air dry moisture content, but it is advisable to reduce the moisture content of short-lived seeds to the "air dry" figure before bagging for storage. Table 2 has been drawn up on this assumption.

Table 2. Maximum Percentage Moisture Content at which Certain Seeds may be Bagged for Storage

Timothy, ryegrasses	14	Turnip, swede, rape	10
Cocksfoot	13	Brassicas	10
Clovers, trefoil	12	Mangold, beets	14
Sainfoin	12	Parsnip	9
		Onion	12
Peas	16	Carrot	10

It is often claimed that the moisture content of a seed lot can be judged by feel and appearance, but this method is not sufficiently accurate with valuable seed; a moisture meter should be used. The carbide moisture tester is probably the most useful for general purposes, since electric meters need separate calibration charts for different kinds of seeds.

* Price 9d. (10d. by post) from H.M. Stationery Office, or through any bookseller.

Special Requirements of Certain Seeds

RED AND WHITE CLOVER Clover seed will cause trouble in most driers fitted with perforated plates, but red clover can often be conditioned in these types if plates with smaller perforations are used. On account of its small size, white clover seed should not be fed into an upright grain drier without having first lined the drying chambers with muslin or hessian. Similarly, on tray driers fitted with perforated plates, it is necessary to line the tray with hessian.

Clover seed is apt to "pack down" and prevent the normal flow of air, and therefore it is sometimes advocated that such seed should be mixed with grain before an attempt is made to dry it.

White clover can be dried most satisfactorily in the head, preferably on a tray drier. Very little seed will be lost by shedding, and a hessian lining to the tray is rarely necessary. Conditioning in this way facilitates threshing, and the heads should be taken to the huller direct from the drier.

GRASS SEEDS These are usually dried on a tray drier or in the bag. Most grass seeds are very light and are inclined to blow off open driers. When this happens it is a common practice to reduce the airflow, but it should be remembered that a reduction in the airflow of driers not fitted with thermostatically controlled heaters leads to a rise in temperature of the drying air, and adjustments must be made accordingly. If the airflow is reduced below a given point the efficiency of the drier is reduced, and it is often better to cover the layer of seed on the tray with hessian to prevent it from blowing off, rather than to reduce the airflow.

BEETS AND MANGOLD These can be dried adequately in almost any type of drier, and many of the continuous vertical grain driers are particularly suited to the purpose.

PEAS AND BEANS There is always the risk of splitting the seedcoat of peas and beans if drying is carried out too quickly. It is therefore advisable, although not essential, to employ unheated air if the seed is very wet. These seeds can be conditioned in nearly all types of driers, and most grain driers are particularly suitable for conditioning large quantities of peas.

ONIONS AND LEEKS Leek heads are very difficult to thresh unless they are perfectly dry, and it is usually essential to dry them artificially if the seed is to be extracted in time for sowing in the year following harvesting. Although onions are not so difficult in this respect, they are frequently treated in the same manner. The heads are allowed to ripen off for several weeks after cutting and then dried on a tray drier lined with hessian, or in a hop kiln. A batch of leek heads may take 7 to 10 days to condition in this way.

TRACTOR WORKING COSTS AT THE LORD WANDSWORTH COLLEGE, 1930-47

A. J. Marval, M.A., N.D.A., N.D.D.
The Lord Wandsworth College, Basingstoke, Hants

TRACTOR running costs of machines working on the Lord Wandsworth College farm have been ascertained annually over the past seventeen years. This mass of data is summarized in Table 1 and compares three periods during each of which the circumstances affecting the cost of operation remained reasonably constant. The most recent figures, those for 1946-47, are given separately.

Table 1. Sub-division of the Period 1930-47

Sub-period	Duration *years*	No. of tractors operating	Total area farmed *acres*
I (1930-6)	6	1	730
II (1936-9)	3	2	880
III (1940-6)	6	3	870
IV (1946-7)	1	4	870

The College Farm It will be noted that in 1936, at the beginning of sub-period II, our farmed area was increased to 880 acres by the purchase of a neighbouring farm, and there has only been a very slight reduction since then. Our cropping system has, however, fluctuated widely over the whole period under review, and these changes are perhaps best seen in Table 2, which shows the proportion of the total area farmed in each sub-period under cereals, cleaning crops and fallow, temporary grass and permanent pasture.

Table 2. Analysis of the Farmed Area

Sub-Period	Total Farmed Area	Percentage of Total Area under:			
		Cereals	"Cleaners"	Temporary grass	Permanent pasture
	acres				
I	730	35	7½	13½	44
II	880	24	14	14	48
III	870	48	14	23	15
IV	870	40	20	30	10

Permanent pasture comprised nearly half our total area in the first sub-period, and cereals formed a high proportion of the arable. In fact there was a tendency to overcrop with corn to the detriment of the land. As a result, in the second sub-period it became expedient to lay down even more land to permanent pasture and to increase the acreage of "cleaners" at the expense of cereals. Sub-period III covers most of the war years and immediately after, when routine cropping systems were discarded. In our case the outstanding changes were the great increase in cereals and an even greater reduction in permanent pasture. The final year of our review is noteworthy for a partial return to a better balanced cropping system.

The soil at Long Sutton varies widely in texture and fertility. At best it is a fairly heavy, flinty loam overlying chalk at a depth of 10 feet or more; in places it is merely a shallow chalk rubble which under pre-war economic conditions was hardly worth cultivating. The greater part of our cultivated

acreage consists of a moderately heavy flinty loam which, judged by clayland corn farming standards, would be considered relatively light and poor, although it has the great advantage of being naturally well drained. Consequently our land will carry tractors fairly soon after a wet spell, so enabling us to maintain a high number of working hours during the year.

Our local climate may be summarized briefly as consisting of a long and usually rather severe winter, followed by a short, cool summer. For these conditions an elevation of 500-600 feet and a north-easterly aspect can be held largely responsible. Generally land work for our tractors is confined to the nine months, March to November inclusive.

Our tractors are, and always have been, of the medium-powered, wheel type, which seems to be well adapted to our conditions and requirements. It is our practice to allot a tractor to one man, making him responsible for its maintenance, and avoiding, as far as possible, any change of drivers. We encourage the use of plenty of good lubricant, and consider these two factors to be largely responsible for the achievement of long life and low running cost in a tractor. We have no elaborately equipped workshop, nor do we possess any highly skilled mechanics for repair work; major repairs and overhauls are carried out at a local garage. Our range of implements could be improved upon considerably to obtain more efficient use of our tractor power. But with our own threshing machine, pneumatic tyres, belt pulleys, a winch, and a range of row-crop tool-bar equipment, we are able to keep our tractors pretty fully employed for most of the year. This is shown in Table 3, and in Figure 1, which shows also the rise in importance of the tractor on this farm at the expense of the horse, a change which was accelerated by the urgent demands of war.

Table 3. Average Annual Working Hours (Total and per Tractor)

Sub-Period	No. of Tractors	Average Annual Working Hours	
		Total	Per tractor
I	1	650	650
II	2	2,250	1,125
III	3	5,000	1,666
IV	4	8,150	2,040

In 1930 we had thirteen working horses fully occupied, but only one tractor. By the spring of 1946 we had reduced our horses in regular use to four, while our tractor strength had increased to four. The rate of substitution would therefore appear to have been made at the rate of one tractor for three horses, but the change is probably actually even more in favour of the machine, if the greatly increased arable acreage is taken into account.

Tractor Running Costs Under this heading we include the following items, but omit the driver's wages, (*a*) fuel and lubricant, (*b*) renewals and repairs, (*c*) depreciation charge, based on a five-year life and a low scrap value, and (*d*) sundry minor expenses, such as licences and insurance. The relative importance of these four items is shown in Table 4. Here we find the total cost of maintaining and working all tractors over the *whole* of each sub-period (with the number of tractors operating given in brackets); also the average cost per working hour for each sub-period. This total cost is then analysed under the above four headings.

TRACTOR WORKING COSTS AT THE LORD WANDSWORTH COLLEGE, 1930–47

FIGURE I. TOTAL HOURS WORKED EACH YEAR

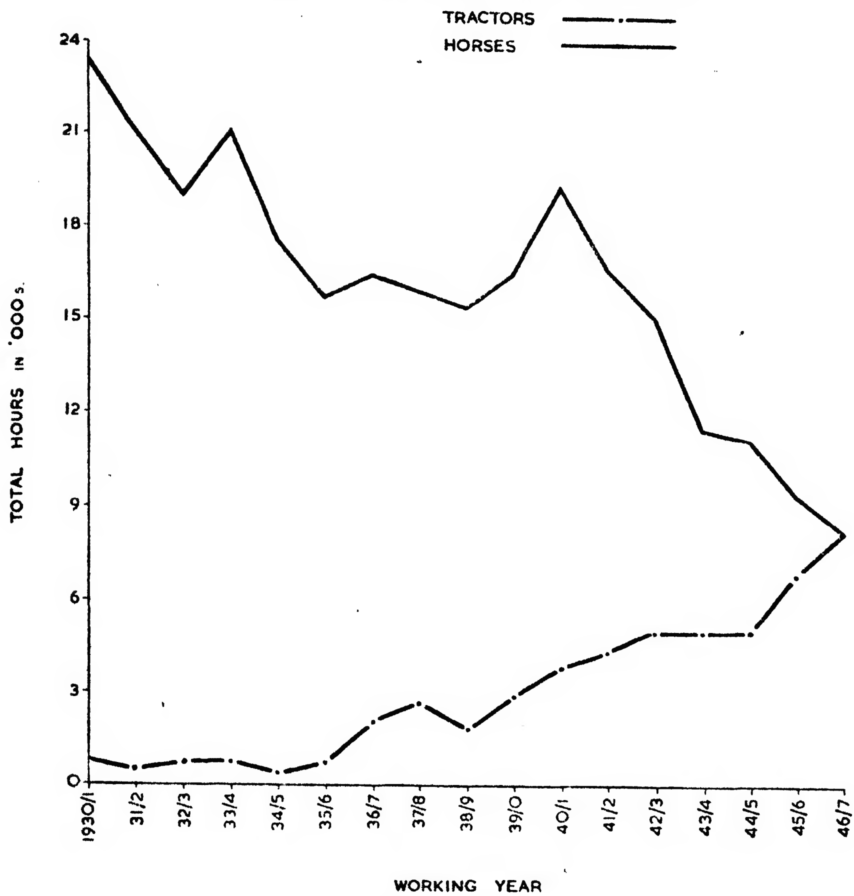


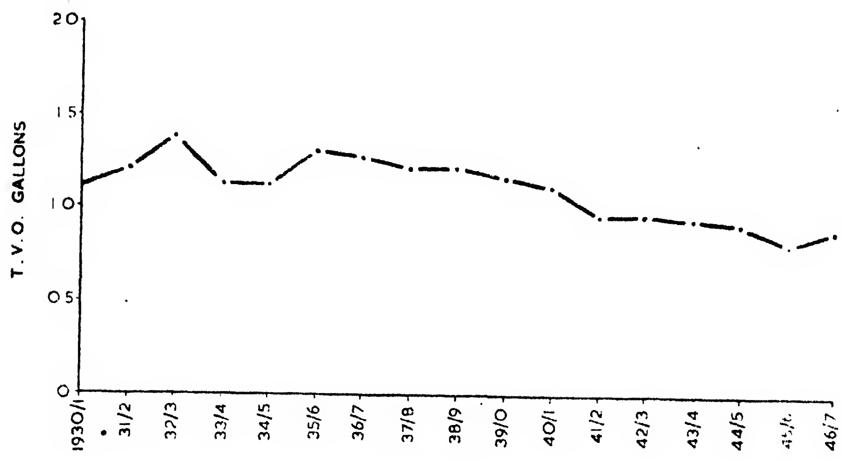
Table 4. Analysis of Total Working Costs

Sub-Period	Total Cost		Analysis of Total Working Costs			
	for sub-period	for working hour	Fuel etc.	Depreciation	Repairs etc.	Sundries
	£	*s. d.*	*per cent*	*per cent*	*per cent*	*per cent*
I	531	2 6 (1)	47.5	34.7	16.7	1.1
II	756	2 4 (2)	52.6	32.8	13.9	0.7
III	3,187	2 1 (3)	61.7	24.8	12.9	0.6
IV	670	1 7 (4)	71.9	8.4	18.2	1.5

Clearly, to achieve low running cost the most economical use must be made of the fuel. Here, as elsewhere probably, there has been an improvement in fuel efficiency (gallons of T.V.O. per working hour) with the greater use made of our tractors. This trend is illustrated in Figure 2, showing the average consumption of T.V.O. in gallons per working hour in each year since 1930.

TRACTOR WORKING COSTS AT THE LORD WANDSWORTH COLLEGE, 1930–47

FIGURE 2. AVERAGE CONSUMPTION OF T.V.O. PER WORKING HOUR



It is of interest to consider the results obtained in each of the sub-periods. For instance although 1930-36 gave us the lowest average annual total cost for a tractor (£90), the low number of working hours per annum (650), and a relatively low fuel efficiency (1.21 gal. T.V.O. per hour), produced the highest average cost per hour (2s. 6d.). At the beginning of this sub-period T.V.O. was costing us 8½d. per gallon, but the price then fell steadily so that in 1936 it was costing 7d. per gallon.

Fuel charges again rose to 7¾d. per gallon in sub-period 1936-39, and were mainly responsible for the increase in the total average annual cost of working a tractor (£125). However, by nearly doubling the working hours per tractor a lower cost per working hour was obtained.

The third sub-period was naturally one of rising prices. For instance, T.V.O., which in 1940 cost 10½d. per gallon, rose rapidly to 1s. 1d. It was maintained at that level until the last year of that sub-period, when it fell to 1s. per gallon. The prices of the other items which go to make up a tractor's working cost rose similarly, so that it is not surprising to find that the average annual cost per tractor for this sub-period is doubled as compared with sub-period I. What is perhaps surprising is to find a 16 per cent cut in the hourly working cost. For this improvement the greatly increased working hours and the more effective use of fuel are responsible.

In our most recent year of working, which ended on March 31, 1947, and forms the final sub-period of this review, we find a slight reduction in the average total working cost per tractor, due partly to the reduction of 1d. per gallon in the price of T.V.O., but also to the fact that two of our tractors had reached their limit of depreciation. But each tractor is now working over three times as many hours as in sub-period I, while we are using almost 30 per cent less T.V.O. per working hour. A reasonably low working cost of 1s. 7d. per hour has thus been achieved.

Finally, it is most convenient to summarize our main findings in tabular form :

TRACTOR WORKING COSTS AT THE LORD WANDSWORTH COLLEGE, 1930–47

Table 5. Summary

Sub-Period	Tractors Operating	Average Hours per Tractor per Year	Tractor Work Cost		Average T.V.O. Consumption per Hour
			Total per year	Per working hour	
			£	s. d.	gal.
I	1	650	90	2 6	1.21
II	2	1,125	125	2 4	1.25
III	3	1,666	180	2 1	0.94
IV	4	2,040	170	1 7	0.88

In next month's issue Mr. Marval will deal with horse labour costs at the Lord Wandsworth College.

THE LIFE OF A PLOUGHSHARE

H. J. Hine B.Sc. (Oxon)

Ministry of Agriculture and Fisheries

THE high rate of wastage of ploughshares in the exceptionally hard soil conditions this autumn has focused attention on the span of life of this part of our fundamental cultivation tool. New methods of prolonging the life of shares by re-tipping them have been devised, and much thought has been given to possibilities of changing the design of shares and the materials of which they are made.

Cast-Iron Shares In Britain cast-iron shares are still the most usual kind, for tractor ploughs as well as horse ploughs. All cast-iron shares now in use are self-sharpening to the extent that they are made to wear slower on the underside than on the upper, a character which is achieved by chilling the share on the underside. This controlled chilling is a British invention, developed by Robert Ransome, and patented in 1803.

It is possible to sharpen the cutting edge of a worn cast-iron share by grinding it on an emery wheel or grindstone, but this is not really worth while. By the time the edge has worn blunt, it is likely that the size and shape of the share will have changed so much that even with a new sharp edge, it will still lack suction, and the plough will not keep into the work. Cast-iron shares cannot be heated and forged to a new shape.

Some economy in the number of cast-iron shares used can be achieved by keeping those that have had to be discarded when hard land is being ploughed, and using them again when the going is easier. Worn shares that are unable to penetrate at all during a dry spell will work quite well when the soil is moist.

Experience has proved that worn cast-iron shares can be re-tipped satisfactorily by welding a piece of hard steel on to them to restore their shape. A very successful method of this operation has been developed by Mr. Balls, a Suffolk blacksmith, who uses pieces of motor-car road spring as the tipping metal. Electric welding is employed to attach the new point to the share.

Steel Shares In America cast-iron shares are little used. Nearly all American tractor ploughshares are made of steel, either plain or soft-centred. Our main experience of steel shares in this country has been on digger ploughs designed to cut a wide furrow. Cast-iron shares wide enough for this work would have to be made very thick to give them sufficient strength, and it is difficult to put a durable sharp edge on a thick share.

Steel shares, both soft-centred and plain, can be re-shaped by hammering after they have been heated in a forge. A good, clean coke forge fire is needed, and the share must be heated to a dull cherry red along the cutting edge. Only as much of the share is made red hot as can be hammered at one time. The heated share is put on the anvil with the bottom of the share lying flat. The upper side of the share is hammered to draw out the edge. When the edge is satisfactorily sharp and the outline shape of the share has been restored, the point is heated again and bent slightly downwards to give a lead to the share to keep the plough in work. Then the whole share is tempered by heating it so that a cherry-red area extends back for half an inch from the cutting edge, and then taking the share out of the fire and allowing it to cool.

This sharpening of steel shares is considered in America to be one of the most difficult and important of the jobs of the farm mechanic. It is rather strange that we in Britain use a share that has to be thrown away when it loses its edge, while the Americans use one that can be re-shaped and used again. It is usually from America that there come ideas of easily replaceable components rather than suggestions for repair: well-known examples are the safety razor blades, to be thrown away when they have lost their edge, and motor-car components that are cheaper to replace than repair.

One kind of share that can be used over and over again, however, has been employed for many years in Britain. That is the bar point share, used in rocky land. A long bar is clamped in a steel wing in such a way that the point of the bar protrudes beyond the wing. Up to a certain point the farther the projection of the bar, the better the plough will penetrate the soil. When the point of the bar becomes blunt it is turned upside down, and a new cutting angle is presented.

Steel Shares likely to oust Cast-Iron Shares Steel shares can be made very durable indeed if their wearing surface, that is, the underside, is coated with a thin layer of specially hard metal. This coating can be applied by oxy-acetylene or electric welding. Cast-iron shares also can be coated, but, so far, the treated shares have not proved satisfactory in all soils.

The length of working life of shares varies enormously with the kind and condition of soil ploughed, and with depth and speed of work. Tests during the development of new kinds of shares have to be made very carefully indeed if they are to give any true indication whether or not a new kind of share is really likely to have a longer life. At the National Institute of Agricultural Engineering a standard method of test for wear has been devised in which loss of weight and change of outline shape can be estimated reliably. Tests have been devised also to measure the resistance of cast-iron shares to impact. This resistance to breakage is an important factor, because very many cast-iron shares get broken by striking hidden rocks and other obstructions long before their points are worn away.

There may still be improvements to come in the methods of casting iron shares, and in the composition of the mixes used, so that resistance to wear by abrasive soils, and resistance to fracture by impact may both be increased;

but present indications are that in the future more and more ploughs will be designed to use steel shares.

ACARINE DISEASE OF BEES

P. S. MILNE, B.Sc.

National Agricultural Advisory Service, Rothamsted, Herts

ACARINE disease of the honey bee is widespread throughout Britain. A survey covering the whole of England and Wales carried out by the Bee Department of the Rothamsted Experimental Station in 1943–44 showed that the incidence of the disease was then 17.3 per 100 colonies, or in other words, that the disease was likely to be present in at least one colony out of every six. Adult bees only are affected—sometimes queens and drones as well as workers—but there may be some neglect and chilling of the brood if the disease causes a sudden loss of bees (as it may, for example, in the spring) and leaves the colony too weak to maintain the brood nest. Much could be done to reduce the incidence of acarine disease, and the often severe loss of bees and honey which it causes, by the application of control measures as a regular part of the system of management—that is, not only to colonies in which the presence of the disease is known or suspected, but also to all colonies in the apiary.

Cause The respiratory system of the adult bee consists of a complex arrangement of breathing tubes (tracheae) and air sacs which carry air to all the organs of the body from a series of openings, known as spiracles, situated on the thorax and abdomen. Acarine disease is caused by a minute parasitic mite (*Acarapis woodi* Rennie) which breeds in the tracheae leading into the thorax from the pair of spiracles lying one on each side of the thorax between the first and second segments.

The adult female mite enters the bee through the spiracle and lays eggs in the cavity of the trachea. The eggs hatch into immature mites, known as nymphs, which develop into adult males and females. Either the left or the right trachea may be infested, or both tracheae if another mature female enters through the spiracle on the opposite side. Nymphs and adults feed at the expense of the bee by piercing the wall of the trachea with their mouth-parts and absorbing the body fluids in which the organs of the thorax are bathed. As their numbers increase they cause a partial blockage of the trachea and its branches within the thorax. The bee is gradually weakened by the activity of the mites, its power of flight is partially or wholly lost, and its useful working life is shortened.

Symptoms and Diagnosis Bees infested with the acarine mites to such an extent that they are unable to fly may be found in the apiary clinging to the stems of plants, or crawling about with fluttering wings on the grass near the hive. Their abdomens may be distended and their wings often have a dislocated appearance, with the hind wing held at an abnormal angle to the body. Such "crawlers" may emerge from the hive in large numbers in the autumn, or following a long period of confinement to the hive in the spring. These symptoms cannot, however, be regarded as characteristic of acarine disease alone, since very similar symptoms can arise from causes unrelated to this disease. Also,

the acarine mite is present within the bee long before the crawling stage is reached, so that the absence of crawlers is no indication of the absence of the disease. The detection, under a low-power microscope or good hand-lens, of the actual presence of the mites, following a simple dissection of the bee to expose the thoracic tracheae, is therefore the only certain way of diagnosing the disease. The thoracic tracheae of a healthy bee have a uniformly smooth, flesh-coloured appearance, whereas those of an infested bee undergo progressive deterioration, marked at first by translucent areas indicating the position of the individual mites within and later by an irregular, patchy discoloration of the tube as the mites increase in numbers. Eventually the tracheae may become quite black and brittle, and full of mites and the by-products of their feeding activities.

Spread
WITHIN THE COLONY

Adult female mites—the progeny of the female which entered the tracheae of the bee which has now become a potential source of the spread of the disease within the colony—are capable of walking out of the tracheae through the thoracic spiracle and of transferring themselves to other bees. These females can, however, establish themselves only in young bees—those which are less than 5–6 days old. Bees which escape infestation during the early period of their adult life are thereafter immune from the disease. The spread of the disease thus depends, firstly, upon the presence of young bees in the hive, and secondly, upon the close contact of these young bees with old bees which are already infested. In the winter cluster, therefore, which will contain no young bees, the mites can breed within the bees already infested in the autumn, but there can be no spread of mites from the tracheae of one bee to those of another.* Many of the old, infested bees will die off during the winter and early spring, but those which survive long enough will contain female mites capable of entering the young bees which emerge following the resumption of brood-rearing in January or February. Young bees becoming infested then will in turn act as sources of spread to later batches of young bees. In this way the disease can be carried on from bee to bee throughout the summer months. During the active season, however, the average life of the workers is in any case short and the presence of the mites may not have any obvious effect on their activities ; but young bees are always available for the migration of the female mites and the latter may well be present in a high proportion of the bees produced in the autumn—in those bees, in fact, on which the survival of the colony through the winter depends. Winter bees normally have a much longer life than summer bees, but if they are infested by the mites their useful working life is shortened and they may emerge from the hive as crawlers, either in the late autumn before the winter cluster is formed, or in the spring when attempting to leave the hive on a cleansing "flight". When the proportion of badly infested bees is high the loss of bees is enough to cause the collapse and death of the whole colony.

FROM ONE COLONY TO ANOTHER

The relevant facts about the first appearance of the disease in a colony can seldom be ascertained, since its presence is not realized by the beekeeper until long after the event, when the first signs of abnormal behaviour among the bees are noticed. Nevertheless, in all new cases there must have

* Recent work in Switzerland, where acarine disease is also very prevalent, indicates that in the absence of young bees during the winter months, the female mites may use the wing-bases of old bees as alternative or "emergency" breeding places, and that the damage caused to the wings in this way is the main reason for the "crawling" symptoms seen in the spring.

occurred a chain of events leading to some form of contact with a previously existing case, either in the same apiary or elsewhere. Such a contact may occur in one or more of several ways. The drifting of infested workers, or drones, gives the mites an opportunity of spreading from one hive to another in the same apiary, as does the transfer of bees from one colony to another by the beekeeper himself if the mites are present in the colony which is being depleted of bees in this way. Again, bees from a diseased colony may join a healthy swarm and be hived with it ; or truant swarms may carry the mites with them and act as sources of spread in a new locality. Robber bees also may carry mites with them into hives containing healthy colonies with young bees of the right age for the migration of the females. Fortunately, however, the mites are not capable of living for any length of time apart from their host bees, so that combs from colonies which have died out from acarine disease are quite safe to use again later—always provided that no other disease, e.g., foul brood, was present in addition. There is also, of course, the possibility that disease may be introduced into an apiary in colonies bought from a dealer or at auction sales where bees are put up for disposal.

Treatment There are two ways in which the mites can be attacked in attempting to control acarine disease. The hive can be fumigated with volatile substances which will either (a) kill all the mites within the tracheae, or (b) prevent the migrating females from transferring themselves to young bees. It must be remembered, however, that even if all the mites within the infested bees are killed, those bees cannot recover from the damage caused to their tracheae, and to that extent the colony cannot be restored immediately to a normal condition of health. This must await the replacement of the old, damaged bees by young, healthy ones. It follows that when the percentage of badly infested bees is high, as is the case when mass "crawling" takes place, there may not be enough active and healthy bees left to enable the colony to survive. An apparent lack of success following treatment may therefore not necessarily be due to any failure of the latter but rather to a natural outcome which was inevitable before the treatment was started. Such cases can be avoided by the routine application of one or other of the methods of treatment described below, since the mites will be unable to establish themselves to any extent in the apiary, and the conditions necessary for mass crawling to manifest itself will not be allowed to arise.

THE FROW OR MODIFIED FROW TREATMENT This is a short-term intensive treatment recommended for application in all cases where acarine disease is actually found to be present, but it should be used only in the late autumn or early spring, owing to its liability to induce robbing at times when the bees are active. If acarine disease is first discovered in the apiary during the active season, the application of the Frow treatment in the autumn should be preceded by the methyl-salicylate treatment (see below). The Frow treatment can also be used effectively as an annual routine measure.

The dosage and method of administration are the same, using either of the following mixtures. If safrol cannot be obtained the second formula can be used in place of the first with satisfactory results. Both mixtures are highly inflammable and poisonous and should be handled with care.

Frow Mixture

Nitrobenzene	2	parts by volume
Safrol	1	
Petrol (or ligroin)	2	

Modified Frow Mixture

Nitrobenzene	6	parts by volume
Methyl-salicylate	2	
Petrol (or ligroin)	5	

Treatment should be carried out either in November or in February, preferably when a day on which the bees have been flying is followed by a frosty day, with a prospect of the cold weather continuing for some time.

Dosage and Administration For a normal colony wintered in a W.B.C. or National brood chamber the following dosage is suitable:

Thirty minims (half a drachm) of either the Frow *or* Modified Frow mixture is poured on to a flannel pad (or on to one of the "contex" gas-mask fittings already made available to beekeepers for this purpose). The pad is then inverted over the feed-hole in the crown-board or quilt. Every *other* day another dose of 30 minims is given on the same pad, seven doses being given in all. After the last dose has been given, on the thirteenth day, the pad is left in position for a further three days and then removed.

When it is not possible to pay repeated visits to the colonies a *single* dose of *75 minims* can be given. In this case the pad should be left in position for fourteen days, or up to three weeks if the weather remains cold.

Precautions should be taken against robbing in the event of the weather turning mild during treatment. The entrances of the treated hives should be reduced to about a double bee space, using a suitably cut piece of perforated zinc in order to maintain adequate ventiliaton of the hive. These small entrances may become blocked on the inside by dead bees falling on to the floor-boards; they should therefore be cleared if necessary with a piece of stiff wire.

Recently the use of nitrobenzene alone has been tried experimentally with some success, instead of the full ingredients of the Frow mixture. Beekeepers who wish to try this for themselves can use it in the same way as the Frow mixture and in similar quantities.

A suitable graduated vessel for measuring the doses may be obtained from a chemist; alternatively a small glass specimen tube could be marked with narrow strips of gummed paper at the 30-minim and 75-minim levels by pouring the requisite quantities of liquid into it from a borrowed measure.

Methyl-salicylate Treatment This is a long-term treatment which is more effective at summer temperatures than in winter. It is consequently suitable for use during the active season, especially as it does not induce robbing. It is useful chiefly as a routine, precautionary measure, but also as a "follow-up" to a spring application of the Frow mixture, when the latter has been used against an actual outbreak of acarine disease, or as a preliminary to the Frow treatment when the disease is discovered during the summer, as mentioned above.

A small bottle with a narrow neck, and holding about one fluid ounce, is filled with methyl-salicylate (also known as synthetic oil of wintergreen, or oil of sweet birch). The neck is fitted with a wick of absorbent cotton extending down to the bottom of the bottle. The bottle is then stood on the floor-board at the back or at one side of the brood-chamber. Another method is to use a small flat tin containing cotton wool soaked in methyl-salicylate and having a number of holes punched in the lid; this is placed on the floor-board towards the back of the brood-chamber and below the frames. To deter the bees from propolizing the evaporating surface, the neck of the bottle (*but not the wick*), or the lid of the tin, can be smeared with vaseline. Any similar method of application can be used at the discretion of the beekeeper; the essential thing is to have an evaporating surface freely exposed and kept replenished with the oil throughout the

summer months. The vapour of methyl-salicylate is actually heavier than air, but the circulation of air normally set up by the bees to ventilate the hive will ensure that the vapour is carried round and among the combs.

Microscopic Examination of Bees Samples of bees from colonies in which the presence of acarine disease is suspected may be sent for examination to the Bee Advisory Officer, National Agricultural Advisory Service, Rothamsted Lodge, Hatching Green, Harpenden, Herts. Each sample should consist of at least twenty-five bees, all taken from the same hive, placed in a match-box or small tin clearly labelled with the name and address of the sender and the number or other identification mark of the hive concerned. Relevant information about the sample should be given in a covering note enclosed with it. Bees showing signs of sickness, collected from the entrance or alighting board, form the most useful material for diagnosis, but if these are not available the sample may be taken from the feed-hole in the crown-board or quilt.

SILAGE—"A WONDERFUL FODDER"

A letter from Mr. A. Richards, Manager of Church Farm, East Brabourne, Ashford, Kent, who describes himself as "a silage disciple in practice"

The Editor, *Agriculture* 15th December, 1947.

Dear Sir,

May I offer my congratulations on the excellent article "Ensilage Problems in Farm Practice," by H. I. Moore, which appeared in the December, 1947, issue of *Agriculture* ? If some of the doubtful ones could see two-year-old heifers with their fore-feet planted squarely on the feeding wagon whilst walking on their hind legs and grabbing mouthfuls of warm silage, they would perhaps be more interested in this wonderful fodder.

At fifteen years of age I landed in Canada, and for five years silage was a most interesting subject to me. Of course, most of the silage made was of maize. The work was not hard, and even so, the condition of stock and winter milk production made up for any extra work. We had a single row cutter and binder, and the height of the crop was sometimes 10 or 11 feet. Sheaves of approximately 10 inches in diameter were dropped and loaded by hand full length across a low two-wheel wagon, taken into the silo and put at once through a cutter and blower. Each farm had its silo attached to the dairy stables and connected inside to the feed passage.

All this was in 1928–29, and of course they have progressed still more since then. After leaving the R.A.F. I was for two years with Mr. A. P. Case of Wilton, Wiltshire, who runs an excellent Canadian Holstein herd. It was here that I came in contact with English silage crops. I can only say that the scope proved by Mr. Case for ley farming, combined with silage cropping, has no limit. In one season, apart from heavy hay, grain and root crops, we made 240–250 tons of finished feed. The crops were oats and vetches, well made—this comes out grand. First-cut clover ley is the best silage ; cattle won't touch dry, sun-scorched hay when there is such succulent feed as young ley silage.

We also made silage from long, coarse cocksfoot, too ripe for hay. This was chopped and blown into a 160-ton capacity pit silo, with plenty of water and liberal molasses. The pit silo, for anyone's information, was made from ex-Army static water tanks, taken apart and rebuilt to size and shape needed. We made this one 45 feet long, 14 feet wide at base and 16 feet at the top, 12 feet high or deep. Actually we had three panels of 4 feet each and 1½ of these were below ground, the other 1½ above, and braced on the outside. Silage was made by hand in two tower silos, and an American Fox River cutter and blower was used for another and the top of the pit silo. We found that the best temperature on inspection each morning was 108° F., and whilst waiting for the dew to go off hay or grain crops, we put in two or three hours cutting and hauling to the silo.

We did experiment with a small round rick silo, made of oats-and-vetch green sheaves, cut with the binder, but this proved unsuccessful, since too much air was able to pass into the rick and the sheaves were not packed down tightly enough

One method we used was to cut a very heavy crop of oats and vetches with the binder, since the vetches were in bloom, and load them on to wagons and draw

in to the blower, cut the cords and run the sheaves through the cutter and blower into the silo, retaining the strings.

I have found that 40–45 ton green crops give about 30 tons of feed. A pit silo, 20 feet long, 14 feet wide and 5 feet high, gives about 28–30 tons of finished silage. For my part I prefer the tower silo, since you can gain more pressure daily and are thus able to keep the whole more airtight. In silage-making the most important point is to keep the outside edges of pit or tower silos trampled down hard and slowly, and keep the centre high by 2 feet always. I should say that a cheap, light cutter and blower would be a great advantage to silage-minded farmers.

A. RICHARDS

OFFICIALLY APPROVED INSECTICIDES AND FUNGICIDES

Since the date of the publication in the September, 1947, issue of *Agriculture* (p. 286), the following names of proprietary products have been added to the approved list under the Ministry's approval scheme.

Miscible Tar Oil Winter Washes:		
Agrisol	Solignum Ltd.	**D 240**
Stock Emulsion Tar Oil Winter Washes:		
Cremul 73	The Murphy Chemical Co. Ltd.	**E 239**
Derris Insecticides to be used as Sprays:		
Polvo	Plant Protection Ltd.	**H 78**
Polvosol	Plant Protection Ltd.	**H 237**
P.P. Concentrated Liquid Insecticide	Plant Protection Ltd.	**H 238**
Copper Fungicides (exclusive of Seed Dressings) to be used as Sprays:		
Wood's C.C.C. Colloidal Copper Compound	Wm. Wood & Son Ltd.	**K 232**
Wetters and Spreaders:		
Potassine	Plant Protection Ltd.	**L 236**
Miscible Petroleum Oil Winter Washes:		
Wintroil Miscible Petroleum Wash	Plant Protection Ltd.	**R 235**
Stock Emulsion Petroleum Oil Winter Washes:		
Monro's Volck Winter Spray Emulsion	Geo. Monro Ltd.	**S 202**
Stock Emulsion Petroleum Oil Summer Washes for Glasshouse Use:		
Monro's Volck Summer Spray Emulsion	Geo. Monro Ltd.	**U 203**
DDT Insecticides to be used as Dusts:		
Wood's DDT Dust	Wm. Wood & Son Ltd.	**AD 228**
DDT Insecticides to be used as Sprays:		
Wood's DDT Emulsion	Wm. Wood & Son Ltd.	**AE 227**
Formaldehyde:		
Vitax Formaldehyde	Vitax Fertilisers Ltd.	**AV 211**

Products C 47, *D* 48, *E* 49, *E* 104, *E* 167 *and O* 170 *have been withdrawn from the list by the manufacturers.*

A leaflet giving the list of approved products may be obtained on application to the Ministry of Agriculture, Government Buildings (Block E), Lytham St. Annes, Lancs.

Ministry of Agriculture and Fisheries,
Plant Pathology Laboratory,
Harpenden, Herts.

December 16, 1947.

NOTICES OF BOOKS

Contributed by Reviewers

Animal Nutrition. (Second edition). L. A. MAYNARD. McGraw-Hill Book Co. $5.

The issue of a new and revised edition of "Maynard" will be warmly welcomed by advanced students and research workers. The nine years since its first appearance, both in spite of and because of the demands of the world war, have produced striking advances in the field of nutrition, notably in respect to vitamins, protein and mineral nutrition, and the nutritional roles of carbohydrates and fats. With the laudable object of keeping his book close to its original size, Professor Maynard has deleted a certain amount of less important material from the original text with no apparent detriment to its value. Unfortunately in his choice of the new material he has been obliged by war-time difficulties to confine himself largely to work carried out in the United States. As a result the not unnatural dominance of American work in his exposition of the subject (which some may have felt to have been rather over-stressed in his original) has been given greater emphasis. Professor Maynard is fully conscious of this and warns the reader that he "should not gain the idea thereby that most of the new discoveries in the field of animal nutrition are being made in the United States. Such is far from the case."

The scheme of presentation of the subject remains unchanged, but one small feature that points to an advantage enjoyed by the American student over his British counterpart, is the list of "visual aids" (films) which in many cases can be obtained from the local film library or local film distributor; also, it appears that many universities have large film libraries from which they can be borrowed.

C.C.

Good Poultry Keeping. (Teach Yourself Farming). C. E. FERMOR. English Universities Press. 4*s.* 6*d.*

Mr. Fermor, who for some considerable time, has been responsible for the table poultry experiments at the National Poultry Institute, Wye, writes with a first-hand knowledge of his subject. Although, as he explains in the preface, there may not be much which is new in what he has to say, the matter is sound. The book does not set out to be highly technical; like other publications in this series, it is intended primarily for the beginner, and it gives the information in a simple and readable form.

Poultry-keeping is a wide subject, and as the book deals with it from almost every angle, it has not been possible to give more than an introduction to many aspects of the business. Nevertheless it provides a useful basic knowledge for anyone wishing to start in a small way.

In the Foreword, Dr. Halnan suggests that the book should be read with diligence and attention, and in these days when there is a good prospect that poultry-keeping can be developed on general farms, it should be helpful to those who may be contemplating extensions. Fifty, a hundred, two hundred laying birds can nearly always be kept with advantage and profit on the general farm, and it is to be hoped that wherever possible developments along these lines will now take place.

The more experienced poultry-keepers may perhaps look upon the information given in Mr. Fermor's book as rather elementary. But it is sometimes useful for the experienced to be reminded of certain simple, fundamental principles, which may have been lost sight of as a result of too long an association with a particular routine.

A criticism of the book is that the recommended rations include foods such as dried skimmed milk and oatmeal, which have not been available for poultry feeding for some years, and others which are still very scarce. It would have been useful if alternative mixtures could have been given.

The data about crosses and crossing will doubtless be read with interest, but a clearer understanding of the principles of heredity is badly needed throughout the poultry breeding industry, and a more scientific approach to this aspect of the subject might well have been tackled even in an elementary textbook.

There is a useful chapter on the Hen and the Egg, which, though short, describes clearly the internal organs and how they function.

The publication is well illustrated, and is one which could, with advantage, be included in every poultry-keeper's library.

J.W.S.

Journal o ithe British Grassland Society Vol. 2 No. 3 (September, 1947).

This number contains the Presidential address by Sir R. George Stapledon on the value and application of strains of herbage plants. Greater knowledge is called for concerning the reaction of individual strains to management practices and also an analysis of the conditions under which individual strains will give maximum sward production. It is remarked that the plant breeder has not yet given attention to the production of strains for special-purpose leys.

Linehan, Lowe and Stewart, in their second paper on the output of pasture and its measurement, give an account of a new sampling method of estimating the quantity of herbage grazed from a given area. This method takes account of the condition in which the rate of growth of grass during the grazing period is greater than that for the preceding rest period and the quantity of growth which takes place while sample areas are being protected from grazing. The results indicate that the new method gives a better calculation of the actual amount of herbage available to the grazing animal resulting in better agreement of the apparent daily consumption of grass with that expected by calculation from generally accepted feeding standards. This agreement is particularly noticeable, as compared with their original method, during periods of rapid growth. However, the coefficient of correlation between the nutrients required by the grazing animals and that provided by the grass as measured by either method is the same. Moreover, the different grazing managements practised in the two years appear to have affected the two methods to the same degree.

Two papers contributed respectively by Pollit and Ellison give interesting data in the yield of leys under such contrasting conditions as cutting for dried grass and grazing reseeded hill land.

The performance of reseeded areas on the Montgomeryshire hills over the first four years provides good evidence of the relative and potential value of various moorland associations when ploughed and reseeded. Such evidence provides a valuable guide in planning hill land reclamation.

T.E.W.

Farming and Mechanised Agriculture, 1948. Todd Publishing Group. (Distributors, Harrap). 25s.

Farming and Mechanised Agriculture is fast becoming an institution among annual reference books—and a very good one at that. This year's volume of 400 pages, like its three predecessors, under the advisory editorship of Sir R. George Stapledon, covers the extremely wide field of agriculture and agricultural interests with pronounced efficiency. It is divided into twelve sections, covering résumés on the present agricultural situation (*Sir George Stapledon*), agricultural legislation, policy and education (*Isabella Williams*) and directories of educational and research institutions, government and public bodies. Statements from official sources and private organizations alike show clearly the essential sphere and scope of the work of each. A list of farming books, periodicals and films, an agricultural "Who's Who" and an adequate index round off a mine of information which reflects the highest credit upon all who have contributed to its production.

S.R.O'H.

Farmer and Stock-breeder Year Book, 1948. 5s

The Farmer and Stock-breeder Year Book, 1948, is exactly what it purports to be—"A Book of Reference for Farmers and all connected with Agriculture". Only the farmer with an elaborate filing system, card indexes and the usual paraphernalia of the modern office can possibly keep track of all the Acts and Orders, rules and regulations that affect his business. This concise and handy compendium will not answer all his questions, but it will, at least, prove itself of real value a hundred times during the year. Within the compass of its 300 pages, a good deal of information is included on official and other agricultural bodies, farm costs and prices, agricultural wages, stock facts and figures, shows, machinery, and tractor specifications. The illustrations of the year's prize animals are excellent and cannot fail to gladden the heart of the farmer with "an eye for a good beast". *S.R.O'H.*

2079 Wt. 16 1/48 CN&Co 466

QUALITY STOCK

AT COMMERCIAL PRICES

For two years we have been progeny testing Sires. We believe this to be the best method of selecting Sires for the Breeding of Pullets, which will not only LAY but LIVE as well.

DAY-OLD PULLETS

R.I.R. L.S.

W.L. x R.I.R.

R.I.R. x L.S.

STOCK COCKERELS

Price List on Application

F. & G. SYKES
ACCREDITED POULTRY BREEDERS
LAVERSTOCK · SALISBURY

The 'Somerspin' P.T.O. Drive Potato Spinner

It's a good job—
It's a 'SOMERSET' machine

—and in line with all other products of the famous 'Somerset' range, which comprises Power Drive Tractor Mowers—Hayrakes—Side Delivery Rake and Swath Turner—Haysweeps—Hayloaders—Hay and Straw Balers—Disc Harrows—Combined Grain and Fertilizer Drills—Grain Drills—Fertilizer Distributors—Ploughs—Sawbenches.

Dening of Chard

Phone: Sales Dept. Chard 2284/5 SOMERSET Telegrams: Dening, Chard

after one dusting with

COOPER'S LOUSE POWDER

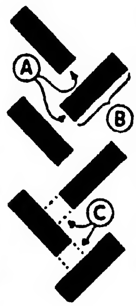
(containing 'Gammexane')

Examine your cattle, housed and unhoused, every month. If you find lice, dust the whole herd thoroughly with Cooper's Louse Powder. One dusting is usually sufficient to kill all lice present and destroy the young lice hatching from the nits. Non-poisonous . . . Non-irritant . . . Does not taint milk. Obtainable from all Cooper Agents.

COOPER, McDOUGALL & ROBERTSON, LTD., BERKHAMSTED, HERTS. Estd. 1843

7¼/39

TRACTOR TYRE *with* PULL!



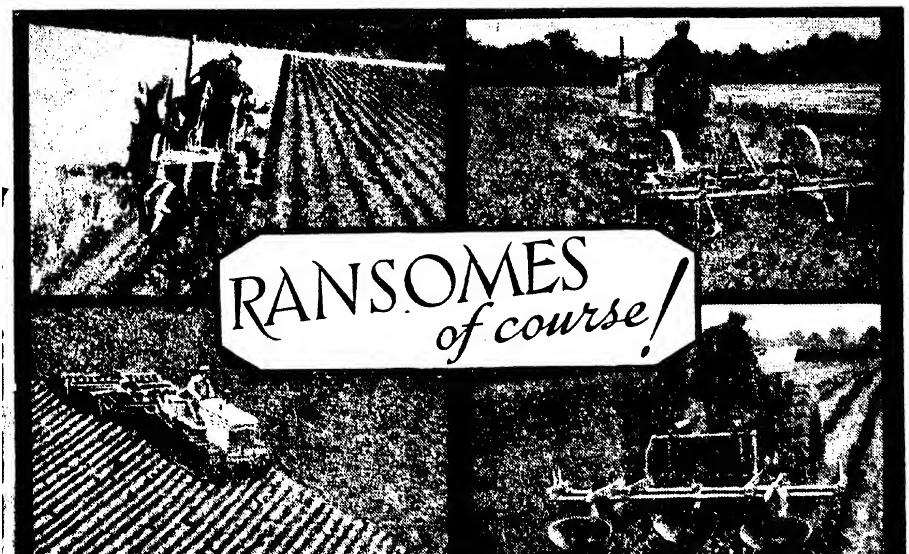
The o-p-e-n c-e-n-t-r-e tread of the Goodyear Sure-Grip tractor tyre gives each tread bar a BITE EDGE (*a*) that permits the entire lug (*b*) to penetrate full depth and length, ensuring maximum grip and pull. Connecting bars (dotted lines *c*) would form mud pockets that fill up, causing slip and spin, and give no point of penetration to start traction bite. The Goodyear tread, which is o-p-e-n at the centre and has no connecting bars, is fully self-cleaning, always deep-biting.

GOODYEAR

SURE-GRIP

TRACTOR TYRE

Please mention the JOURNAL *when corresponding with Advertisers*


RANSOMES
of course!

rtisers

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

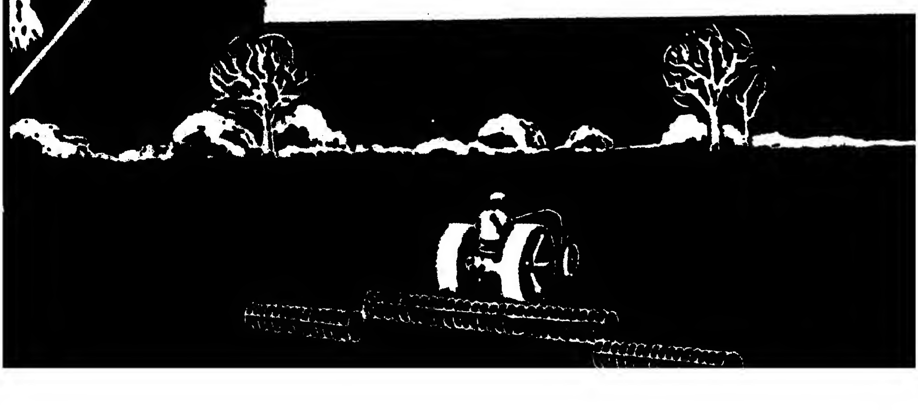
VOL. LIV No. 12 MARCH, 1948

Contents

H. M. STATIONERY OFFICE

LONDON · EDINBURGH · MANCHESTER · CARDIFF · BRISTOL · BELFAST

Price Sixpence Published Monthly



Please mention the Journal *when corresponding with Advertisers*

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

Editorial Offices: Ministry of Agriculture and Fisheries, 55 Whitehall, London, S.W.1. Telephone: Whitehall 3400

¶ *Provided that the source is acknowledged in each instance, such articles and notes as are published in this Journal without any specific reservation regarding copyright may be reproduced in any registered newspaper or public periodical without special permission. The Ministry does not accept responsibility for statements made, or views expressed, in signed contributions to this Journal or in those reproduced from another source.*

¶ *Further, the Ministry does not accept responsibility for any of the private and trade advertisements included in this publication.*

¶ *All communications respecting advertising in the Journal should be addressed to the Advertisement Contractors, Sawell and Sons, Ltd., 4 Ludgate Circus, London, E.C.4. Telephone: Central* 4353.

VOL. LIV **No. 12** **MARCH, 1948**

POTATOES ARE WORTH GROWING WELL

J. C. WALLACE

County Advisory Officer, Holland, Lincolnshire

MANY more potatoes are required this year to meet the greatly increased demand and to enable the Government to abolish the rationing of this foodstuff. The acreage targets given to each county are being met, although some farmers say the crop is not profitable.

During the war the required acreages were obtained in non-potato growing counties by compulsory Orders and the crop was often grown on unsuitable land. Also many farmers disliked the idea of growing potatoes; they expected the crop to lose money and endeavoured to reduce their loss by spending as little as possible on it. They tried to save on cultivations, seed, and fertilizers, forgetting that these are the very items on which good yields largely depend, and that whether the yield is high or low, expenditure on planting, harvesting and preparing for market is much the same. In business it sometimes happens that "x" expenditure will mean a loss, but "x" + "y" expenditure will bring a profit, and this is very true of potato growing. Certain expenditure must be incurred, i.e., preparing the land, buying the seed, planting, and harvesting. This outlay we can call "x," which may give a low yield and a low financial return. Add "y," represented by thorough and efficient cultivation, better seed, and plenty of fertilizers, which will ensure a good yield and a high financial return, and we get a profit.

This approach to the potato crop should alter the farmer's attitude towards it; he will then give it the best land available, and instead of leaving it the last crop to be planted, he will get it in as one of the first. Experienced potato growers look on the potato as the backbone of the farm, and the good results they get are not always due to good quality land; indeed many of them are taking land in non-potato growing areas and are getting double the crops obtained by local farmers.

What are the common faults of the inexperienced potato grower? Briefly they are: (1) the crop is grown on poor land, (2) the land is badly prepared, (3) poor quality seed is used, (4) planting is done too late, and (5) insufficient fertilizer is applied. Success therefore depends very largely on correcting these faults.

Selecting the Field and Preparing the Land Although easy working land is the more convenient, with modern equipment heavy land has ceased to be the problem it was some years ago. Potatoes do best after a soil-improving crop, such as seeds or ley, ploughed-up pasture, beans or peas. There is some risk of wireworm damage on ploughed-up permanent pasture but this will be lessened by ploughing the turf well under. Potatoes will succeed after a straw crop, provided the land is well dunged. Therefore, as you will have to spend more money on the potato crop than on any other, select the best available field on the farm.

Good crops cannot be expected on shallow land. Therefore plough 8 inches deep and, if possible, subsoil a further 6 or 8 inches. This really should be done in the early autumn, but light pasture land may be ploughed in the early spring. Get the turf well down.

Seed Potatoes Most farmers know that "old" seed should not be planted, but some growers still use it. Others understand that a "change" of seed is necessary but assume that as long as the seed comes from another district, or even from a nearby farm, everything will be all right. Old seed, that is, seed from a stock more than one year from Scotland or Ireland, should not be used; in circumstances of exceptional shortage twice-grown seed may have to be planted.

Certified Scotch or Irish, or certified English-grown seed will be satisfactory, but it is unlikely that supplies will be sufficient. There are, however, fairly good supplies of once-grown seed, that is, seed from a stock brought from Scotland or Ireland last year, but this should be obtained from a district known to produce good seed.

Obtain the seed as early as possible. Do not wait until planting time before ordering or taking delivery. It is more than likely it will not be available immediately and this will mean very late planting.

Few growers outside the main growing areas possess chitting houses, but seed can be kept quite well if it is spread out thinly on a frost-proof barn floor. Alternatively put it in small outdoor clamps covered with plenty of straw and a layer of soil to keep out frost. Get the seed under cover as soon as it arrives, unless it can be planted immediately. Do not leave it in sacks for more than a few days.

The first sprouts are the best, and in the clamp, or even on the barn floor, they tend to become elongated and brittle and easily damaged. Therefore plant early, just when the eyes are well open.

Approximately 1 ton of seed will be required per acre. Cutting the seed reduces the quantity required per acre, but this is risky in the drier parts of England.

Preparation for Planting Start as soon as the land is dry enough in the spring—towards the end of March if possible. In any case endeavour to finish planting by mid-April. Don't anticipate a late frost and delay planting. Potatoes are caught more or less in most years, but they soon recover.

Cultivate or drag the land at least 6 inches deep and break it down to a reasonably fine tilth. Then draw ridges 27 or 28 inches apart and at least

6 inches deep. Either a tractor with ridging bodies or a three-row ridger may be used. If you are not equipped with these but have a ridging plough, get it out and on to the job instead of waiting for the Agricultural Committee to come and do the work for you.

Manuring No factor in potato growing pays better than the money spent on manuring. The basis should be a moderate dressing of farmyard manure, 20 loads per acre, ploughed in with the autumn ploughing. In areas of high or moderate rainfall the farmyard manure is put in the bottom of the ridges and the seed planted on top of it, but this means extra work at a busy season.

In addition, a compound fertilizer, containing properly balanced proportions of nitrogen, phosphate and potash, should be used. National Compound No. 1 is suitable for most soils. Order the compound now, take delivery at once and store it in a dry shed. For small areas straight fertilizers may be mixed at home, e.g.:

2–3 cwt.	sulphate of ammonia
4 ,,	superphosphate
1–2 ,,	muriate of potash

After ridging broadcast from 10 to 15 cwt. of fertilizer per acre along the ridges. This can be done just as well by hand as by machine. Concentrated fertilizers should be used at half these rates. Your District Advisory Officer will advise you about fertilizers and quantities.

Planting Most growers will have to plant by hand. This is the practice in the main growing areas. Planting machines are now more common, but the average grower will again have to hire, and this may mean delay.

In most cases the seed will not have been sprouted in trays, therefore planting will have to be from baskets or buckets. Handle the seed carefully. The eyes will probably be just open but rough handling will damage them.

Space the tubers evenly in the bottom of the furrow 14-16 inches apart, and see that the planters bend down and *place* them in position. Photographs nearly always show the planters walking upright and dropping the sets from the height of the basket. That is the wrong way.

Cover the sets by splitting the ridges, using special bodies on the tractor, or a three-row coverer, or a ridging plough. The tractor must run on the top of the ridge, and if a horse-drawn coverer or ridging plough is used, the horses must walk on the top of the ridge.

After-Cultivation If the young shoots have to grow through much depth of soil they will be weakened. Therefore, about a fortnight or so after planting, harrow down the ridges very nearly level: 2½ inches is an ample soil covering. Then start inter-row cultivation, using cultivating tines on a tractor—three tines to each row—or a horse-drawn drag or scarifier. Repeat this frequently until the plants are ready for earthing up. Many growers re-ridge the field and then harrow down after a few days. This destroys weeds along the rows.

When the plants are several inches high they should be harrowed with light harrows. This operation does very little damage to strong plants and benefits subsequent growth. Leave a narrow strip unharrowed and see for yourself. Many good growers now harrow a second time when the plants are 6 inches or more in height. If harrowing is not carried out it will be necessary to hand-hoe between the plants to destroy weeds and move the soil.

The last operation will be earthing or hilling up. This should not be done too soon but when the plants are 9-12 inches high. Earthing up is

done to throw more soil round the plants and prevent greening of the tubers. Here breadth or width of the new ridge is more important than height and the ideal is a ridge semi-circular in shape, rather than that of an inverted "V."

Having got the crop thus far, nothing more can be done to ensure good results except to prevent damage by Blight. Contract spraying is carried out by many County Agricultural Committees or by local contractors. If in spite of preventive treatment, Blight does appear on the foliage towards the end of the season, the haulm should be destroyed immediately with a solution of sulphuric acid.

Summary If you grow potatoes, you must spend a fair amount of money. Don't try to save on this under the impression that it will increase your profit or reduce your loss.

Thorough preparation of the land is essential.

Use good seed, certified if possible. If you can't get this, buy once-grown seed from a reliable source.

Plant early—before mid-April.

Handle the seed with care.

Use plenty of dung where available and a generous dressing of balanced fertilizer.

Harrow down the ridges, cultivate frequently between the rows and harrow the plants when 6 inches high.

Take precautions against damage by Blight.

If the crop is worth growing at all, it is worth growing well.

SILAGE-MAKING IN NORTHERN IRELAND

T. Moore, M. Agr.
Ministry of Agriculture, Northern Ireland

THE practice of conserving green fodder in the form of silage has been known in Northern Ireland for over sixty years. It has never been widely adopted as normal farm practice, but has been confined mainly to a few of the larger farms equipped with a tower silo and a cutter-and-blower.

During the late war a campaign was conducted with the object of encouraging farmers to produce high-protein silage from young grass to replace imported feedingstuffs. Many farmers made silage during the war years but only a small proportion adopted silage-making as routine farm practice. The reason given most frequently by farmers for not continuing to make silage is that the labour required to fill the silo, and to consolidate the material sufficiently well to secure a satisfactory product without waste, is too great.

Many different types of silo were used, and a detailed account of the results obtained with various types of silo in one county has already been published(1). The majority of the silos were containers of one sort or another, which possessed the common feature that the material had to be forked in, distributed over the enclosed area of the container and consolidated—all by human effort. This work, which is heavy and monotonous, accounts for the greater part of the labour required in making silage. If it is not carried out with skill and care, the wastage around the sides and on the top of the silo may be discouragingly high. For this reason more attention has been given in recent years to the design of silos which can be filled with less heavy forking and in which the material can be consolidated by more effective and less tiresome methods than treading.

Pit Arable Silage—A Case in Point The following account of a case where silage was made from an arable crop in 1947 illustrates how silage can be made successfully in a simple pit from material which is difficult to ensile successfully even under the best conditions.

A dairy and poultry farmer who wished to maintain his milk output and to increase his output of poultry products, decided to make silage for the dairy herd in order to release the maximum quantity of feedingstuffs for the poultry. The silage was to be made on land rented for the season and, as none of the pastures carried a sufficiently good sole of grass and clover to produce grassland herbage for silage, it was decided to grow an arable crop. The seed mixture used consisted of: 6 stones oats; 4 stones rye; 2 stones maple peas; 1 stone Italian ryegrass, per statute acre. The ryegrass and rye were included not so much for their contribution to the silage crop as to ensure a heavy crop of aftermath for grazing or for a second cut for silage. The quantity of maple peas used in the mixture was kept low deliberately because the *p*H of the soil was found from soil analysis to be 5.1, and it was rather doubtful whether a leguminous crop could succeed in such a soil. It is interesting to record that the peas did, in fact, grow well at this level of *p*H. Beans were not included, since it was considered to be too risky to attempt ensiling, without chaffing equipment, a mixture in which they featured. It was intended to sow the silage crop in March and to ensile it in early June, before the hay harvest commenced. (The hay harvest from permanent meadows normally begins about the end of June in this locality.)

Unfortunately the weather defeated this intention, and sowing was then delayed until May 1 in the hope that the hay harvest would be almost completed by the time the crop was ready for ensiling. The soil in which the crop was to be grown was in a poor state of fertility, so a manurial mixture consisting of 1 cwt. sulphate of ammonia, 4 cwt. superphosphate, and 1 cwt. muriate of potash, was applied at the rate of 5 cwt. per acre. It was planned to apply a further dressing of a nitrogenous fertilizer at the rate of 1 cwt. per acre about three or four weeks before cutting, but as the crop grew very well the farmer did not consider this necessary.

A Simple Pit As part of the silage was to be fed to dry stock on the fields during the winter, the farmer decided to ensile the crop in the field and to cart silage as required for the dairy herd during the winter. Because the land was rented only for the season, a temporary silo was used; a simple pit being selected in preference to any form of portable structure above ground. A pit 34 feet long and 6 feet deep was excavated in a dry bank. The width at the bottom was 10 feet and at the top 12 feet. The floor sloped to one end, where drainage was provided. As there was little risk of water seeping into the silo from the sides, it was not lined with concrete.

Daily Filling The crop was considered ready for ensiling about the middle of July, when the rye and oats were about to shoot and the peas were in flower; but as the hay harvest had been delayed by bad weather, the farmer decided to wait until most of the hay had been saved before filling the silo. Filling was eventually started on August 1 and completed on August 14. Naturally the cereals had become rather mature by this time but the Italian ryegrass, which had been growing rapidly at that stage, assisted very materially by contributing a leafy, succulent herbage to the mixture.

About three-quarters of an acre was cut and ensiled each day, the work being carried on continuously, except for Sundays and one or two days devoted to completing the hay harvest. The material was collected by hay-cart and emptied at the side of the pit, whence it was forked into the silo and spread by hand. The mass was consolidated with horses after each load was added. Molasses, diluted with water, was applied at the rate of one gallon to each ton of herbage.

Trimmings and waste herbage were thrown on the top of the material which was trampled by horses for about half an hour daily for several days after filling had been completed. The ensiled crop was then covered with about 2 inches of soil, and a waterproof cover to exclude rain.

The Silage When the pit was opened in November the silage was found to be excellent throughout. There was a layer of top waste about 2 inches deep, mainly the waste material used to seal the silo ; side waste was negligible. A sample of the silage was submitted to the Chemical Research Division of the Ministry of Agriculture for analysis and, as was to be expected, the crude protein content of the dry matter was found to be rather low—13.96 per cent. Moore and Willcox (2) have shown that the protein content of cereal-legume silage depends on the legume content of the mixture, and the stage of maturity at which the crop is ensiled. In the present instance the legume content was low and the crop relatively mature when ensiled. The *p*H of the silage was 4.23.

The production of good silage from such material with practically no waste in the silo is attributed to the thorough consolidation with horses, and demonstrates the main advantage of pit silos, in which the material can be consolidated by horse or tractor, over containers in which consolidation must be done by human treading. A modest estimate of the yield of silage from the 7 acres of crop was 45 tons.

Costs A record was kept of the cost of producing the herbage and of filling the silo. These costs are set out in the following table :

	Total cost for seven acres			Cost per ton of silage			Percentage of total cost
	£	*s.*	*d.*	£	*s.*	*d.*	
Rent	14	0	0		6	3	13.2
Ploughing (by contractor)	8	15	0		3	10	8.2
Sowing seed, harrowing and rolling	5	12	0		2	6	5.2
Seeds	22	11	6		10	0	21.2
Manures (less residual value)	14	17	0		6	7	13.9
Cost of applying manures	1	8	0			7	1.3
Cost of producing crop	**67**	**3**	**6**	**1**	**9**	**9**	**63.0**
Cutting crop	1	15	0			10	1.6
Loading and carting	8	15	0		3	11	8.2
Filling and treading	24	10	0		10	11	23.0
Sealing		12	0			3	.6
Molasses	3	15	0		1	8	3.6
Cost of making silage	**39**	**7**	**0**		**17**	**7**	**37.0**
Total Cost	**106**	**10**	**6**	**2**	**7**	**4**	**100.0**

	£	*s.*	*d.*
Cost per ton of dry matter	14	17	9
Cost of crude protein per cwt. as silage	5	6	7
Cost of crude protein per cwt. purchased as dairy meal	5	9	4

Horse labour is charged at the rate of 1s. per hour and manual labour at 1s. 6d. per hour.

Against the cost of producing the crop, which is high, must be set the fact that the same crop produced aftermath grazing (9.4 cattle grazing weeks per acre), and will also produce a crop of ryegrass hay in 1948.

Nevertheless this silage, made from an arable crop, is much more expensive than grass silage made under similar conditions. The cost of making grass silage has been estimated at 23.14 shillings per ton(1). Although labour rates were slightly lower when the grass silage costings were collected, there is no doubt that where pastures bearing a good sole of grass and clover are available, it would be a much more economic undertaking to make silage from grass. This is particularly desirable at the present time when the maximum acreage of cereals and roots is required.

In spite of the fact that the silage made was not a high-protein product capable of completely replacing meals in the ration, and that as a source of protein it was as expensive as purchased meals, the farmer in question has found it possible to maintain his output of milk and at the same time to reduce considerably the quantity of meals fed to the dairy herd. It is modestly estimated that sufficient meals can be reserved to provide food for 60 head of poultry for one year, and that must be regarded as a considerable achievement on a small farm.

References

1. Moore, T. (1947). *Jour Brit. Grassl. Soc.* **2,** 11.
2. Moore, H. I. and Willcox, J. S (1945). *Jour. Min Agric.* **51,** 502.

LINSEED

F. W. Burmann
Coleshill, Amersham, Bucks

I STARTED growing linseed a number of years ago. I have grown it in different fields on two of my three farms at Coleshill, at an altitude of 400–550 feet above sea level on the outskirts of the Chiltern Hills. The top soil is, in general, rather shallow, varying from 6 to 9 inches, and belongs to the classification "gravel over chalk". This means that the subsoil is well drained, but it also means that in a dry season there is "burning up".

I decided to grow linseed for various reasons, but primarily to obtain the seed for addition to the rations for my dairy cows, for putting some "bone" into young pedigree bulls reared for service, and, because of its immunity from wireworm attack, to use it as a "spear-heading" crop when ploughing up grass fields. I grow winter wheat, winter and spring oats and barley, apart from the usual forage crops, including lucerne, which I find an excellent standby in a dry season; it roots so deeply that drought seems to make no impression on it. I have also tried to grow sugar beet to get some pulp for feeding to stock, but my land is too shallow, and I have had little success with it. In my endeavour to be as self-supporting in feedingstuffs as possible, I have tried various high-protein crops, including beans and peas, and the greatest success I have had to date has been with linseed.

By trial and error much has been learned about this crop. Details of my experience under contrasting conditions in which one variety of linseed has been grown here, may assist others who likewise wish to grow more protein on their farms, and thereby help themselves and the national economy by this dollar-saving crop. At £55 per ton for seed produced, it is also a crop that pays well.

Experience on Three Fields The following table shows the methods used in three different fields A, B and C, which are situated about a quarter of a mile from each other:

Table of Three Linseed Crops

Description	Field A	Field B	Field C
Seed Variety	English-grown Redwing	From crop A	Redwing (Canadian origin)
Rate of Sowing	60 lb. per acre	80 lb. per acre	80 lb. per acre
Time of Sowing	First week April	Second week April	Second week April
Preceding Crop	Old pasture	Kale	Old grass
Cultivations	Ploughed up November: disced twice, end February; spike-harrowed once, early March	Ploughed (once) February; disced twice and spike-harrowed once in March	Ploughed up February; disced twice in March; not harrowed; flat rolled May
Lime and Fertilizers	Limed 1 ton per acre after plough; barley type fertilizer 3 cwt. per acre before sowing	No lime; No fertilizers	No lime; top-dressed with 1½ cwt. sulphate of ammonia per acre in May
Time of Harvesting	Late September, after Barley	Early September	Mid-September
Method of Harvesting	6-foot tractor-binder; stooked in field for two weeks and stored in Dutch barn for two months	As previous column	5-foot tractor binder; stooked and threshed in field two weeks later
Threshing	Threshing drum with small seed riddle	As previous column	As previous column
Yield per acre	11 cwt.	8 cwt.	16 cwt.

The situation of the three fields is shown in the aerial photograph.

Field A was sown with a seed-barrow, the holes of which were partly closed to prevent the seed running too fast. This field was part of a large field most of which was sown down to barley (yielding 11 sacks of seed per acre), and barley fertilizer had been applied all over the field before barley and linseed were sown. The linseed was used mainly for seed, as it was an excellent, clean sample. On two sides the field is adjoined by woodlands populated by rabbits, but the crop was not touched.

Field B. The lower yield, compared with Field A, was due to following a green crop such as kale, and perhaps also due to lack of fertilizer, but it is interesting that a wheat crop taken after the linseed showed a marked improvement in yield. The seed was sown by seed-barrow as on Field A.

Field C is rather sandy, and it was decided to roll it really well to get as firm a seedbed as possible. The field had a mossy, stale sward of old grass and was very dirty ; it had not been ploughed for over fifty years.

There were very few weeds in the linseed, which was followed by winter oats (a clean field now). The field was infested with wireworm, but the linseed was not affected at all. The smaller tractor-binder used was easier to handle and cut the crop well.

A Fine and Firm Seedbed Sowing by seed-barrow is hardly a proposition for large areas ; it is a laborious and less accurate job than sowing with a tractor- or horse-drawn drill. Fertilizer should not be drilled with the seed, which gets a better start by applying fertilizer separately before sowing. Linseed does not require much fertilizer as my table shows, especially after grass, when stored fertility should nourish the seed adequately. This season I intend to follow the advice and experience of another grower by applying a barley type of fertilizer before drilling, at the rate of 3 cwt. per acre. The field in question has been down to a ley for five years following three straw crops and shows signs of exhaustion. It was last limed at the rate of 2 tons per acre two years ago, and in this instance lime will not be applied before linseed is sown. The field has just been ploughed, and it will remain untouched until March for the weather to produce the fine tilth required for this crop ; it will be disced twice and given fertilizer before we go over it with spike-harrows. After drilling and harrowing it will be flat-rolled into a fine and firm bed, and I do not anticipate that it will have to be rolled again later. No top dressing will be used.

I think it is very important to establish a firm seedbed ; this brings subsoil moisture to the seed and ensures a high germination rate. Particular care was taken in this respect with Field C—with most gratifying results.

Thresh when Dry I have heard the complaint that linseed is a late harvester—usually later than barley. The time of harvest must necessarily depend, in my view, on the use of fertilizer, start and type of cultivations, and, of course, the weather ; but if linseed can be harvested later than grain crops, I personally consider this to be an advantage in these days of labour scarcity, since it enables the harvesting operations to be spread instead of having to deal with them all at once.

It is important that the crop should be really well-dried before threshing. When the crop was threshed in Field C (see table) it was found that in the morning (when moisture was prevalent) threshing proceeded slowly, whereas later in the day, with rising temperature, or in a warm wind, threshing caused little difficulty. The drum speed should be about 80 to 100 r.p.m., and the machine should be set with the wind blowing into the straw-shaker end, and the wind shutter completely closed. The linseed should be fed slowly and evenly. The drum can be cleared by a cereal straw at the end of the threshing, a small quantity of which will clear away the sticky residue usually left by this crop. If the harvested seed is mixed with weed seeds, e.g., charlock, it is wise to winnow it and remove all "strangers". I do not wish to give the impression, however, that linseed is a "dirty" crop, as some people think ; at least, that is not my experience.

Another objection sometimes raised is that it is likely to rob the soil. I see no reason why it should ; on the contrary, I have found on my land that following crops have yielded higher. Maybe the reason for these objections is to be found in out-moded husbandry, or in experience based on old-fashioned seed varieties that cannot compare with the modern types of seed, especially those now supplied from Canada. It may also be that

linseed (for oil) has at times been confused with flax (for fibre). The latter differs greatly in regard to cultivations and harvesting, but the seeds look so alike that the Council of the Royal Agricultural Society of England has recently decided to investigate methods of clearly differentiating between the two varieties. In America and Canada linseed is called "flax," which may also have added to the confusion.

The disposal of the straw is admittedly a problem, but I believe that eventually it may find its use in high-class paper manufacture (as in the U.S.A. and Canada). In the meantime it can serve on the farm for cattle shelters (it is highly weather-resistant) and for rick bottoms.

Criticism has also been levied against the cake allocation scheme from home-produced linseed. I should like to see a larger share of the cake myself, although the present special allocation of 1 ton for every 3 tons of seed is very useful, but I suggest that it goes too far to imply, as did one correspondent in a recent farming publication, that "there is no point in producing linseed cake for someone else to feed". By the same token we might as well stop growing wheat for other people's bread!

Linseed and Increased Butter Fat My experience has led me to the belief that linseed can be grown on almost any clean land on which barley can be grown. The cultivations and sowing operations are indeed rather similar to those for barley. This season I intend to grow the largest acreage of linseed I have yet attempted, and I should like here to give dairy farmers what may be a valuable tip: the butterfat content of milk produced from my herd was frequently increased considerably when a fair quantity of linseed chaff (in which quite a few seeds had been left) was added to the dairy ration. In fact, in a period of twelve months' official recording, the best butterfat test compared favourably with similar periods in preceding years. I question if this is just coincidence, as my experience is borne out by other growers of linseed, notably one Berkshire grower not far from here whose pedigree herd of Dairy Shorthorns shows greatly improved butterfat tests whenever his home-grown linseed chaff is fed to the herd. This point may well deserve further investigation, since linseed would be an invaluable crop to a dairy farmer if it could be established beyond any doubt that its presence in the dairy ration will raise butter fat, and thereby the quality of the milk.

WEED CONTROL IN LINSEED AND FLAX

PROFESSOR G. E. BLACKMAN and K. HOLLY, B.Sc. (Agric.)
Department of Agriculture, University of Oxford

LINSEED and flax have been given the twin evil reputations that they exhaust the land and are dirty crops. No precise evidence has ever been produced to substantiate the first objection; in fact all the signs point the other way. The second objection is a mixture of fact and fiction. It is true that if the crops are sown late on badly prepared seedbeds, then they are not as likely as some other crops to compete effectively with the weeds. In consequence, when it comes to harvest time the smother of weeds not only makes heavy work for a small return but leaves behind an unwanted heritage of weeds and weed seeds—a heritage that will do much to rob and exhaust the next crop by competing for the available soil nutrients.

Differing Problems Although the first essential for good crops of both linseed and flax is to sow early on a well-prepared and clean seedbed, the national need for a greatly expanded acreage of linseed may in many cases necessitate the use of land not entirely weed-free, and in these circumstances a new means of control by selective herbicides would have much to commend it. This would be especially beneficial if the new technique permitted crops to be grown on fields where until now the presence of aggressive weeds, like white charlock, has made the prospect of good crops merely a pious hope.

Since 1942, first at Imperial College and subsequently at Oxford, investigations supported by grants from the Agricultural Research Council have been going on to discover practicable ways and means by which weeds can be destroyed without damaging either linseed or flax. The problems have taken longer to solve than the investigations on weed control in cereals because linseed and flax are not so resistant to herbicides as spring oats and barley. Because of this narrower gap between the susceptibilities of the weeds and the resistance of the crops, the weed control techniques have stricter limitations, and some of the compounds which can be used with relative impunity on cereals find no place for weed control in linseed or flax. In fact the position is even more complex, for some of the recommendations that apply to linseed do not apply to flax. This contrariness is caused by the differential effects of the herbicides ; while some may in no way interfere with seed production they may still cause loss in fibre production.

Because of this inconsistency, it is essential to regard the weed problem in linseed as different from that in flax. There are first, however, a number of warnings equally applicable to both crops. Though sulphuric acid may be excellent in cereals* and onions, its use is quite out of the question for linseed and flax, because the chances are that the crop will suffer more than the weeds. Again, when it comes to the dinitro-ortho-cresol (DNOC) type of herbicide, it is imperative not to use either the ammonium salt or a DNOC suspension because here again there is a grave risk of severe damage. This risk does not apply to the *sodium* salt so long as it is not activated with ammonium sulphate, no wetting agent is added, and the recommendations in this article are followed precisely.

Linseed and the Growth Substances For weed eradication in linseed, the synthetic growth substances show the greatest promise. The two most active compounds which can at present be obtained commercially are 2-methyl-4-chloro-phenoxyacetic acid and 2 : 4-dichloro-phenoxyacetic acid, which can be abbreviated to MCPA and DCPA respectively (the latter is known in America as 2-4 D.). MCPA as the sodium salt may be used without risk *up to a concentration of* 0.2 *per cent* of the pure compound, which, at the standard rate of a 100 gallons of spray per acre, amounts to 2 lb. per acre. The safety margin of DCPA, whether it is the sodium salt or a suspension of the acid, is not as great, since the experiments show that as the concentration is increased DCPA will start to cause a reduction in seed yield. In consequence the concentration of DCPA *must not exceed* 0.1 *per cent*, which is the equivalent of 1 lb. per acre.

One of the recent developments is the use of esters of the growth substances. As these are not soluble in water, they are dissolved in oil and then emulsified. *Such ester-oil emulsions are quite unsuitable for linseed* ; mixtures of this type may even kill the whole crop outright.

* The latest methods of selective weed control in cereals have been described in a previous article—*Jour. Min. Agric.* (1946) **53**, 16—and in Advisory Leaflet No. 315.

Successful weed control in linseed not only includes using the right compounds at the right concentrations but it is also essential to spray at the right time. *It is of paramount importance to wait until the plants are* 3-4 *inches high before they are sprayed,* and spraying must have ceased before they reach 12 inches. Spraying too early or too late will each lead to injury of the linseed, but as there is not much time to spare in seasons of rapid growth, plans should be made in advance to spray the crop as soon as the plants are 3-4 inches high. Moreover, the earlier the weeds are treated the better will be the kill.

After spraying, the linseed may show some temporary twisting of the stem, especially towards the tip, but this twisting will soon disappear and in no way affects seed production or seed quality.

Flax and the Growth Substances In the application of weed control to flax totally different considerations apply, since maximum fibre production takes precedence over seed yield. The maximum concentration of MCPA which can be sprayed on linseed without reducing either seed or straw yield cannot be used in flax because it depresses the amount of fibre recoverable in the factory. But if the concentration is reduced to 0.075 per cent as a maximum, there is very little risk. There is also the need to be even more careful to spray at the most resistant stages of growth. At the outset the plants should be at least 4 inches high, and spraying should not go on after they are 8-10 inches high.

Whether DCPA is an alternative to MCPA for weed control in flax has not yet been investigated, but as DCPA is more toxic to linseed than MCPA, it is reasonable to suppose that DCPA may cause a loss of fibre unless the concentration is decreased well below 0.075 per cent. Thus at the present time there is a greater risk of using DCPA on flax, and moreover at such low concentrations only a few weed species would be destroyed.

Sodium DNOC With the reduction in the permissible concentration of MCPA for flax, it may on occasion be better to use as an alternative the sodium salt of DNOC: but there are provisos. *Not only must it be the sodium salt* and no other DNOC compound, but the concentration *must not exceed* 0.6 *per cent* of the pure compound. Therefore since the ordinary commercial pastes contain a variable amount of water, due allowances must be made when making up the sprays.

Again, the plants must be sprayed only in the resistant phase (4-10 inches high). Under this set of conditions the yield of fibre is unaffected; so also is the straw and seed yield. Thus sodium DNOC can also be used to kill weeds in linseed.

Linseed as a Cover Crop Linseed is sometimes used as a nurse crop for the establishment of long leys, and the occasion may arise when the crop and "seeds" are in danger of being smothered by weeds. To meet this tribulation the use of sodium DNOC and the growth substances is impracticable, since there will be a risk of killing the clovers and harming the grasses. The only course is to spray with copper chloride at a concentration not exceeding 1 per cent. Even then one must wait until the clovers have at least two true leaves, the grasses are well established and the linseed is between 4 and 12 inches high. Copper chloride at this concentration will, however, cope successfully with only a few species of weeds like yellow charlock and penny cress, and leave untouched other species which can be killed by the growth substances.

Susceptible Weeds So far the main emphasis has been placed on the sorts of materials that can be employed and the precautions that must be taken to ensure that linseed and flax are not injured. The picture would not be complete, however, without some indication of the kinds of annual weeds that can be controlled by the recommended treatments. Since the behaviour of each individual weed species is a law unto itself, no simple set of rules can be formulated. The best that can be done to summarize a complex situation is to draw up in tabular form the likely reactions of the common annual weeds to the different compounds and this has been done in the table on p. 542.

The table lists the degree of kill that can be expected for twenty species when they are sprayed with MCPA, sodium DNOC or copper chloride within the limits of concentration set by the crop. It should be stressed that the estimates can only be the nearest approximations, since much will depend upon the stage of growth and the conditions at the time of spraying. For example, where the plants are listed as resistant (R), this does not mean that no plants will be killed : rather it implies that the kill will be less than 50 per cent, but some of the survivors are likely to be so stunted that the crop will grow away from them. Nevertheless it is better to avoid sowing linseed on fields where resistant weeds like willow weed, knotgrass, speedwell, mayweed, goosegrass and chickweed are likely to appear. In such cases reliance on chemical methods of control is too much of a gamble.

It will be noted that the table contains no mention of DCPA which can be used safely in linseed alone at a 0.1 per cent concentration to kill yellow charlock, treacle mustard and penny cress. For other weeds requiring a higher (0.2 per cent) concentration, it is better to use MCPA.

The growth substances also have the valuable attribute that they will stunt the shoots of perennial plants like creeping thistle (*Cirsium arvense*) and docks (*Rumex* spp.). This stunting effect is more evident when the perennial shoots have developed a good leaf surface, but under most conditions it would be unwise to delay spraying on this account, because the resistance of the annual weeds will be increasing.

Most farmers are by now familiar with the technique of spraying with the growth substances, copper chloride and DNOC compounds in cereal crops, and the same procedure and precautions are needed for linseed or flax.* Because of the greater sensitivity of linseed and flax, it is imperative to find out from the manufacturers the constituents and concentrations of proprietary herbicides. Since lower concentrations must be employed, it is also essential for maximum efficiency to choose a fine day so that rain does not wash the herbicide off the leaves before it has had time to penetrate. This is particularly important for spraying in flax.

Dusting No reference has yet been made to the possibilities of using dusts instead of sprays in both these crops. Experience has shown that spraying is more effective than dusting and is to be preferred when the weeds do not belong to the *most* susceptible type. But where water is scarce or a spraying machine is not available, dusting may save the situation. At present the dusts on the market contain approximately 1 per cent of the active material, and if they are to be applied evenly by a fertilizer distributor, a minimum rate of application of 2 cwt. per acre is required. In consequence, the quantity of compound put on will add up to a little over 2 lb. per acre, and this therefore limits the feasibility of dusting to linseed and the active compound in the dust to MCPA.

---

* The technique of spraying with these herbicides is fully described in Advisory Leaflet No. 315.

An Experiment in Weed Control Finally, to illustrate the potentialities of weed control in linseed it may be well to quote the results of one experiment. In the spring of 1946 an inquiry was received about the possibility of sowing linseed on a field which had been ploughed late, because of the season, and was known to contain a plethora of white charlock. The farmer was informed that investigations were still in progress, but since he was willing to take a chance the whole field was sown down to Redwing and arrangements made to spray the white charlock with MCPA, except on an area reserved for a further experiment. After spraying with a range of concentrations, the trial plots were ultimately harvested and threshed, and whereas the control weed-infested plots gave a yield of 3.4 cwt. of seed per acre, those sprayed with 0.1 and 0.2 per cent MCPA gave yields of 9.7 and 10.0 cwt.—a gain of up to 190 per cent. Moreover the percentage oil and protein contents of the seed did not differ significantly from the controls.

Although large increases like this cannot always be expected, the experiment does serve to illustrate the part that the new technique of selective weed control can contribute to the attainment of a greater linseed acreage.

SELECTIVE CONTROL OF ANNUAL WEEDS IN LINSEED AND FLAX CROPS

Recommendations for Type of Compound and Maximum Permissible Concentration in Each Crop

Weed Species	Amount of Compound in Pounds per 100 Gallons per Acre			
	Linseed only		Linseed and Flax	Flax only
	Copper chloride	MCPA	Sodium DNOC	MCPA
Yellow Charlock	10***	0.75–1.0***	6**	0.75***
Treacle Mustard	10**	1.0***	6**	0.75**
Penny Cress	10**	1.0***	6**	0.75***
Shepherd's Purse	R	2.0***	6*	0.75**
Black Bindweed	10**	2.0*	6*	R
White Charlock	10*	2.0***	6*	0.75*
Corn Poppy	R	2.0**	6*	0.75*
Fat Hen	R	2.0**	6*	R
Goosefoot or Orache	R	2.0**	6*	R
Hemp Nettle	10**	2.0**	6*	0.75*
Corn Marigold	R	R	6*	R
Shepherd's Needle	R	2.0**	R	0.75*
Spurrey	R	2.0*	R	R
Fumitory	R	R	6*	R
Knotgrass	R	R	R	R
Willow Weed	R	R	R	R
Speedwells	R	R	R	R
Mayweeds	R	R	R	R
Goosegrass	R	R	R	R
Chickweed	R	R	R	R

*** = over 90% kill expected, ** = over 80%, * = over 50%. R = weed resistant.

THE MACHINE AND THE SOIL

H. J. Hine, B.Sc. (Oxon.)
Ministry of Agriculture and Fisheries

THE raw materials of agriculture are sun, water and plant foods, but the vehicle, the working medium, is the soil. No other trade has to deal with a medium so varied and variable. The designer who wants his machine to sell in large numbers must enable it to work over a wide range of soils and a diversity of climatic conditions.

In general, designers have succeeded all the better for disregarding some of the local demands which, in the past, have influenced manufacturers to make many different types of each implement to suit particular soils. Some types of machines, however, are simply unsuited to some kinds of soil, and alternative methods of cultivation have to be used. Some deep-digging rotary cultivators, for example, make some soils so fluffy that no subsequent surface cultivations can be carried out until a couple of seasons have elapsed and allowed the soil to settle again. Other soils poach so easily that they can be tackled only under certain moisture conditions, and then only with special implements.

Complicated modern farming machines have often to be stoutly constructed in order that they will stand up to their job, and it may be feared that the greater weight of such machines would compact the soil harmfully. There is, however, little evidence of this. Track marks may frequently be seen in a field of young corn where carts have crossed the field before sowing time. Sometimes these tracks show up as dark lines, from which it can be supposed either that the seeds along the tracks were slower to germinate or that the shoots were longer in reaching the surface. In some instances the lines are brighter and greener than the surrounding crop, which may suggest that compaction in the tracks has benefited the plant. The effect probably depends upon the weather immediately preceding and following the passing of the cart over the field.

In any case, such differences in growth as these usually disappear before harvest time. Experiments have shown, however, that in some special conditions germination can indeed be reduced considerably in the wheel tracks of a heavily ballasted pneumatic-tyred tractor drawing a drill. This result is probably due to insufficient penetration of the hardened soil by the coulter of the drill. It is not likely to be a serious matter in agricultural practice, because most corn drills have fairly strong springs, or fairly heavy weights to assist the penetration of the drill. Moreover, cross-harrowing after sowing would probably break up the track and bury the seed more deeply. The risk can be avoided by fitting track-removing tines behind the tractor wheels.

Soil Grip and Rolling Resistance: Wheels

The peculiar nature of soil presents many difficulties in tractor design, because the whole process of applying power to the land depends on the grip of the wheels or tracks upon the soil. This is true whether the implement is tractor-towed or self-propelled.

Very often the performance of the machine is limited by the soil grip rather than by the power of the engine. Tractors more often stall because of wheel slip than from engine overload. Even when the wheels or tracks are gripping, more power can be lost by the rolling resistance caused by the strakes or spade lugs as they enter or leave the soil than in the whole of the transmission gearing from engine to back axle.

Soils are rarely in the right condition to allow wheels or tracks to grip by friction alone. Sometimes they are too dry and powdery; more often

they are too moist. Therefore cleats or spade lugs on steel wheels and tracks, or deep bars on rubber wheels, are needed to help the grip by imprinting a rack along the surface of the soil. When the lug has penetrated the soil, the rotation of the wheel or track presses the lug against the wall of the hole into which it has pushed itself. Grip then depends upon the resistance of the soil to shear, and this varies considerably with the kind of soil and the condition it is in.

Occasionally muddy soil packs around the spade lugs and reduces their effective length. Open- or skeleton-type driving wheels have been used to remove this difficulty. These wheels have no broad rim ; they consist simply of a disc with lugs fitted round the circumference, and so give less lodgment to mud.

The grip of wheels, and the rolling resistance they offer in their passage over the soil, vary with the size, shape and number of the lugs or bars, the overall diameter of the wheels, and the weight on them. They depend even more on the kind of soil and its condition.

TRACKS There are some soils upon which at certain times of the year it seems quite impossible for any kind of wheels to obtain sufficient grip to transmit the power of a large engine. This fact led designers, even in the early days, to try to contrive some form of tracklaying device. It was soon seen that these tracks were going to do their job all right, but at first the pins and bushes forming the joints of the links of the tracks were made of materials which had to be lubricated. The bearing surfaces, however, could not be kept free from the soil in which the track had to work, and the grit from the soil mixed with the oil to form a grinding paste which very soon wore out the pins and bushes. Nowadays the track joint is formed by a hardened steel pin in a hardened steel bush, and this bearing is run dry and lasts remarkably well.

On most full tracklaying tractors the diameter of the driving sprocket is smaller than would be the diameter of the driving wheel on a wheel tractor of similar power. The track assemblies themselves are heavy and compact, and the whole construction can be arranged so as to keep the machine's centre of gravity low. This low centre of gravity gives a feeling of safety to the driver when he is turning the outfit on a steep headland or doing sideling work. The half-track machine has a larger driving sprocket, but the idler is small and near the ground, and the machine has good stability. It should be noted, moreover, that the large diameter of the driving sprockets is not inherent in the half-track principle ; it is used on present-day machines chiefly because the tractors were designed primarily as wheel tractors, and if the diameter of the driving sprocket were made very different from that of the driving wheel it replaces, the forward speed of the tractor in its various gears would become unsuitable.

The maintenance cost of tracklayers is higher than that of wheel tractors largely because of wear in the pin-jointed tracks and in the sprocket wheels that drive the tracks. The amount of wear in these places depends very largely upon the kind of soil in which the track has to work ; it is particularly heavy in some sandy soils.

Rubber-jointed tracks, such as are used on market-garden and other small tracklayers, are not susceptible to wear by grit, but this kind of track is not used at present on high-powered agricultural machines.

Full tracklayers are steered by slowing down one or other of the two tracks. Half-track machines, however, retain the ordinary front steering wheels of the wheel tractor. The track assembly is a substitution for the rear driving wheels.

On the full tracklayers the track is flexible in both directions ; that is to say, the joints allow the links to pivot through an angle on either side of the direction of the lie of the track. In the most common kind of half-track, however, the links are designed so that the track can fold inwards, but if it is folded outwards, away from the sprocket, it comes to a position where the links interlock and cause the track to form a rigid girder. This girder is not in a straight line ; it is in the arc of a circle of very large diameter. The driving sprocket is in front of the idler sprocket, and not behind it, as it is on the full tracklayer. Therefore, the part of the track in contact with the soil, and bearing the weight of the tractor and transmitting the drive, is in compression instead of being in tension, and the links are clamped against each other instead of being held together only by the pins.

Probably one of the reasons why tracks have, in general, a lower rolling resistance than spade-lugged wheels is that the cleats or grousers do not need to be so large on tracks, and that they are subject to less movement while they are actually embedded in the soil. A long spade lug on a small diameter wheel must be swinging quite fast all the time it is in the ground, but the lugs on a flexible track are probably nearly stationary for most of their stay in the soil.

Methods of measuring rolling resistance with any accuracy are difficult. Slippage can be measured directly and easily. We can calculate how far a tractor would travel for a certain number of revolutions of its driving wheels or driving sprockets if there were perfect ground grip and no slip whatever ; and we can measure how far it actually does travel. The difference between these two distances represents loss of forward speed due to slip. But measuring the loss of energy due to rolling resistance presents many problems. We can tow the tractor and measure its resistance to being towed, but we have no assurance that the resistance of the wheels or tracks when they are being pulled over the soil is the same as their resistance would be when they are transmitting power. However, though we cannot directly measure rolling resistance in the driving tracks or wheels, we can deduce it if we can first measure the overall efficiency of the track or wheel.

Weight and Wheel Performance With wheels, one of the factors greatly affecting their performance is the weight upon them. The weight upon the driving wheels when the tractor is at work may be very different from the weight upon them when the tractor is at rest. The pull of the implement can cause weight to be transferred from the front axle to the back axle.

By judicious adjustment of the height of the drawbar hitch, this transfer of weight can be used to help the wheel grip ; it can also be used experimentally to measure the efficiency of the driving wheels and, indirectly, to estimate their rolling resistance.

The overall efficiency of a driving wheel or track is the ratio between the energy available from it as drawbar pull, and the energy transmitted by the mechanism of the tractor. With a wheel the input of energy can be calculated from measurements of the reaction tending to lift the front of the tractor off the ground when a load is being pulled at the drawbar.

Once the overall efficiency of the wheel has been determined, the rolling resistance can be estimated by assuming that the total loss of energy is due to slip and rolling resistance.

A great deal of inquiry has been made into the factors affecting the rolling resistance of pneumatic tyres when the wheels are being drawn over the soil. This work has been in connection with the development of tyres for carts and implements, and although its findings cannot be used directly for application to driving wheels, they can help in a consideration of

the best kind of wheels to use on the front of wheel tractors and half-track tractors. It is likely that in some soil conditions the present front wheels can offer quite high resistance to the forward movement of the outfit. Indeed it may be that one of the reasons why four-wheel drive machines are good in some soft soil conditions is that the front wheels can pull themselves out of their self-made depression, instead of having to be pushed out by work transmitted through the rear wheels.

For most experiments on traction it has been found better to use dynamometer loading cars rather than actual agricultural implements. The size of the load is then always under control, and changes in its value can be made in small, accurately gauged steps. But this method of loading causes the tractor to be working under conditions rather different from those which it would encounter if it were ploughing, cultivating or harvesting. For one thing, if many runs have to be made, and great stretches of land are not available, the outfit has to travel over the same strip repeatedly, and the soil may acquire a different character after each trip. Moreover, ploughing, which after all is the biggest job most tractors are called upon to perform, means that a small wheel tractor is put to work under a very special condition, one difficult to imitate when a loading car is used. The land-side driving wheel is travelling on the ordinary field surface, but the furrow-side driving wheel is travelling on a platform of newly cut soil. This newly cut face usually provides a much better surface for wheel grip than does the ordinary field surface. The tilt of the tractor also takes weight off the land-side wheel and transfers it to the furrow-side wheel. A medium-sized tractor may weigh 14 cwt. at each back wheel when the tractor is on an even keel. If, however, the tractor is tilted so that one side is 8 inches lower than the other, as it may be when ploughing, the weights at the two back wheels may be about 11 cwt. and 17 cwt. respectively.

That particular condition, however, is confined to small and medium-sized tractors. High-powered tractors usually plough a bout wide enough to allow the tractor to ride wholly on the land without the necessity to offset the plough sufficiently to cause side draught. Indeed, with crawlers, whether full tracklayers or half-tracks, it is most undesirable that the tractor should have one track in the furrow; the tilt causes too much side thrust on the tracks.

Much research work has been done on wheels. It is now known that a large overall diameter for driving-wheel pneumatic tyres is desirable for work in every kind and condition of soil, and that in nearly all conditions of soil a narrow section tyre grips just as well as a wide section tyre.

Ballasted Tyres Driving-wheel performance depends much less on the inflation pressure in the tube than it does on weight, and grip will rarely be helped by reducing the pressure in the rear tyres to cause great deflection of the tyre where it is in contact with the ground. The deflected part of the wall of an excessively soft rear tyre on a tractor pulling a heavy load takes on a complex curvature, a kind of ripple. This is because the tractive effort is being taken through that deformed part of the tyre. The softer the tyre the more pronounced is this ripple. This complex deformation of the wall of the tyre, which takes place every time the wheel revolves—perhaps a thousand times an hour—must shorten the life of the tyres. Research has shown that the extreme deflection does not help performance. It is weight that is wanted, and a sufficiently high pressure of air in the tube of the tyre to withstand that weight. To provide the weight driving-wheel tyres can be ballasted in three ways: (1) by bolting weights to the wheels, (2) by carrying extra weight on the tractor platform, or (3) by filling the tubes of the tyres with water instead of air.

Putting water in the tubes is a cheap way, and, besides adding ballast to assist grip, the water does good by reducing the bounce of the tractor.

It is well, however, to use an anti-freeze solution instead of water only. The actual freezing of the water is not likely to stretch the casing of the tyre enough to damage it, but if the tractor were driven while ice remained in the tubes, the edges of the ice may break the rubber of the tube or cord of the tyre. In Britain the practice has been to fill only about two-thirds of the tube with water and leave the other third for air. This air is pumped to the pressure deemed necessary for that particular tyre and job, taking into account the weight added by the water, and the additional air pressure that will be necessary to sustain the additional weight. The weight of water is about 2 cwt. in a normal-sized rear tyre. A development in U.S.A. practice is to fill the tube completely with water, leaving no air at all, but some workers have lately decided that it is better to leave at least a very small air pocket. The air chamber cushions the shock of jolts better than water alone, since air is two thousand times as compressible as water.

Whether the inertia and flywheel effect of a fixed mass on the wheel is desirable or undesirable, and to what extent a liquid filling rotates with the tyre, are unsolved problems.

Weight is not as essential for the grip of spade-lugged steel wheels as it is for the grip of pneumatic tyres. It need only be enough to cause the lugs to penetrate the soil sufficiently for a large enough area of lug to be pressing horizontally against the soil to push the tractor or implement forward. In soft soil the area necessary will be larger than in hard soil, because the resistance to shear is weaker; but the lugs will more easily penetrate the soft soil, and so the weight required on the tractor may not be any greater.

Tracks, also, need little weight to assist their grip; indeed the weight of unit area of soil contact can be kept extremely low without the track slipping. Occasionally, however, long cleats, or grousers, have to be fitted to the track shoes to help the grip.

The Soil Workability Factor Attempts have been made to classify soils and map them according to their interaction with machines, but research has not been taken very far.

The property of the soil that would have to be classified to provide data for estimating the machinery requirements of any given area of land, or to provide figures for advisory work on the capital equipment needed to do the cultivation of a farm, is the number of days a year in which the soil could be worked by implements and could provide grip to tractor wheels or tracks.

As an example, let us take a tractor and plough which can do 4 acres of work a day. If the ploughing could be spread over, say, three months, the outfit could look after 200 acres. But suppose the soil is that kind of clay that one week is too soft for wheels to grip on it and too sticky to scour off the plough, and next week is so hard that it cannot be penetrated. Then, to look after 200 acres of ploughing we shall need several tractor outfits instead of one, and we may need tracklayers instead of wheel tractors to deal with the job on days when the soil is workable but the surface has not sufficient shear resistance to allow the wheels to grip.

What is wanted is a measure of the amenity of the soil in various conditions of weather. This could be measured and expressed as the range between the water content of the soil at the sticky point, and the water content at the solid or powdery state, the stage at which the soil is too dry to be worked. This factor—let us call it the "workability factor"—would need to be interpreted carefully, and only in conjuction with other informa-

tion, such as subsoil data. Nevertheless, if we could devise a quick method of recording these two moisture contents, the one at the sticky point, and the other at a point at which the soil is too hard or powdery to be worked, much benefit would come from adding this test to the list of routine observations of soil.

The position of the sticky point could be agreed upon without further experiment, but the position of the other limit might require field trials to relate tractor drawbar pull, implement resistance, and so on, to the moisture content of the soil.

It might be possible to combine these additional observations with some that would be useful to other workers, such as civil engineers, who regularly make tests for Atterberg Plasticity Index. Atterberg named the various consistencies of a material as Liquid, Semi-Liquid, Plastic, Semi-Solid, and Solid, and he suggested that the plasticity of a soil could best be measured by the range of water contents over which it could be considered as remaining in a plastic state. He laid down methods suitable for clays and silts for determining the limit of the liquid state, and the limit of the plastic state, and he used these two limits to calculate what he called the Plasticity Index. The methods and apparatus have since been modified. The present modified specification used to define the plastic limit in these tests for plasticity index is the water content at which the soil crumbles when it is rolled into threads of one-eighth inch diameter. The liquid limit is determined as the state of a soil such that a given number of hammer blows by a standard implement are needed to close the gap in the soil made by a standard graving tool.

These limits do not quite correspond with the points that interest the agriculturist—the sticky point, and the point at which the soil becomes too dry to be worked. But perhaps these two points could be added to the Atterberg range, so that by choosing items from the same set of observations the civil engineer could calculate his plasticity index, and the agriculturist could calculate his workability factor.

References

1 RUSSELL, E W. and HINE, H J. Measuring the Efficiency of a Tractor *Empire Journal of Experimental Agriculture* (1941) 9, No. 34

2. GRACE, H. Liquid and Plastic Limits R A F Airfield Construction Course. *Department of Scientific and Industrial Research*, July-August, 1943.

3. Research on Pneumatic Tyres. *National Institute of Agricultural Engineering*, 1945

4. BLACK, E B, BOMFORD, D R, HINE, H. J. and WARBURTON, J R. Wheels, Tracks and Half-tracks *Institution of British Agricultural Engineers*, October, 1946.

Correction

The Conservation of Fodder Crops for Winter Feeding. R E SLADE, D.Sc (January, 1948), page 446, para 2, read · " but the carotene in dried grass is comparatively stable."

RECENT DEVELOPMENTS IN MACHINERY FOR MARKET GARDENING

DUNCAN MCGUFFIE
Alcester, Warwickshire

I SHOULD like to establish from the outset that the following remarks are based on personal experience on my own farms and from what I have seen in the Evesham district. It is necessary to make this clear—because soils and conditions vary so widely that a machine which gives excellent service in one district may be quite useless in another. Nevertheless it is extraordinary how a really good machine seems to work well under all conditions and in nearly all districts, whereas the mediocre machine commonly works satisfactorily in only a very limited number of districts.

The development of power-driven machinery for market gardening, in contrast with farming, has been slow, but remarkable progress has been made during the last four or five years. The smaller and more fastidious market gardener preferred the horse for his ploughing and drilling. The tractor padded the soil too much and was too clumsy to work well in confined spaces, but all this has been changed. Light, easily manoeuvrable and very handy tractors have come on the market in considerable numbers.

Hydraulic Linkage As is often the case with agricultural machinery, comparatively minor changes in design have meant an almost overwhelming difference in the practical use of the machine on the land. Not many years ago, a British agricultural designer had the brilliant idea of mounting implements directly on to the back of a tractor, using a well-balanced linkage, coupled with a hydraulic system to raise and lower the implement. This in itself is a minor change in design, but once a plough or other implement is attached to a tractor in this manner, it can be made to carry out first-class work in the most confined and awkwardly shaped fields. As tractor drivers well know, it is practically impossible to "back" a trailer plough—the plough simply "curls" like a snake—but with a hydraulic linkage system the plough can be raised, backed up to within an inch or two of a brick wall and then dropped into its work.

I have a kitchen garden attached to the farm, and about half an acre of this is used for raising brassica plants. In past years it has been hand dug, but with increasing wage rates this proved too expensive and we therefore had recourse to hiring a two-wheeled walking tractor. The resultant work was, however, not deep enough and the tractor had to be hired again for subsequent cultivation. With a hydraulic linkage tractor it has now been found possible both to plough and cultivate satisfactorily, even within this small space.

On the farm a plough or scuffle attached by hydraulic linkage leaves no headland, and appears to take less pulling than trailer implements. Last autumn we used one of these scuffles to lift carrots. The ground was very hard at the time and our local women were unable even to fork them out. We tried first a crawler tractor with a trailer scuffle and took a strip two feet wide down the side of the piece. The job did not go well, for once we had cleared two strips three-quarters of the scuffle was working in loose ground while the other quarter was working in the carrots, thus causing the scuffle to go askew and throw the tractor out of balance. We then tried a medium-sized tractor, with a scuffle attached by the hydraulic linkage system, and took the full width of the scuffle down the piece of carrots. The rubber wheels did no damage to the top of the carrot roots and the scuffle loosened 80 per cent of the crop ; only very few were broken or damaged and the crop

was lifted most economically. The value of the hydraulic lift was proved time and time again. Whenever the carrot tops started to choke the scuffle tines, a touch on the hydraulic lever raised and cleared the whole scuffle frame. We have not yet experimented with such crops as parsnips but there seems every chance that this machine will be an invaluable asset to the market gardener.

Harrows may be attached to a tractor by this system with considerable advantage. In the old days a set of harrows pulled by a horse could be cleared easily by the man walking behind them, but with the coming of the ordinary tractor every time the harrows required cleaning, the driver had to stop, get off, clear them and remount the tractor. The result was that the harrows were not cleared as frequently as they should have been. With the linkage system the harrows can be lifted, the tractors moved forward and the clean harrows dropped on fresh ground without the driver dismounting. No doubt in the course of the next few years we shall find nearly every implement except the roll mounted directly on to the back (or front) of the tractor in this way. It would be most useful today to have seed and manure drills similarly attached to the tractor.

So it is that a quite minor change in design has brought in its wake a whole succession of major improvements to the worker on the land. Clearly, it is of the utmost importance that research workers in agricultural and horticultural machinery should work continually in the closest cooperation with farmers and market gardeners.

Small Tractor for Row-crop Work Yet another comparatively small change in design has led to the invention by British designers of a type of machine that is ahead of anything else in its class in the world This is a small tractor which is capable of sowing and cultivating market-garden crops where the distance between the rows is as narrow as 12 inches. The design of this machine is very interesting. When seed was sown broadcast there was very little padding and the sower could see what he was doing. Next came the horse-drawn drill with the driver behind. The driver could see the seed well enough, but under wet conditions there was the slight disadvantage of the drill not always running true in the horses' hoof marks. Next came the tractor-drawn drill, and it became necessary to have two men, one on the tractor and one behind the drill, and there was even more padding by the tractor in front of the drill than there was with the horse. (It should be noted that a drill pushed by hand is ideal, in that there is no padding before the drill and the man behind can see the flow of seed into the soil. On my farm the hand box-shaped drill is still used in wet weather.) But in this new type of machine the seed boxes come first, the driver next, and the engine and driving wheels last; the seed goes into untrampled ground, the operator can see the flow, without need for a second man, and the driving wheels come at the rear where they can do little harm.

These tractors are capable of sowing five or six rows a foot apart at four to five miles an hour and can accomplish 10 acres a day. When the crop has been drilled the seed boxes, which are built into an oblong frame, can be removed bodily from the tractor and replaced by a similar frame into which are built hoe legs readily adjustable on a central spindle. These hoe blades can be adjusted to within an inch, or even less, of either side of the row of young plants.

One of the secrets of inter-row cultivation by machinery is to hoe the same number of rows as drilled, then should the driver err from his line when drilling he has a reasonable chance of following the same small error when hoeing, a little overlapping being allowed for by the machine taking only

half each outside row. But when, for instance, four rows are drilled and an attempt is made to hoe six, then any error in drilling results in the crop being cut and destroyed at hoeing time.

The art of hoeing by machinery has made considerable progress during recent years. Because the blades on a horse-hoe were fixed solid on the central beam, and their depth over hard and soft ground was controlled by the skill of the driver, the early toolbars had blades fixed in the same way. A furrow or uneven surface made these blades either skimp their work or bite into the soil too deeply, but the modern machine hoes have independent spring-loaded knee action which allows each hoe blade to work at constant depth despite uneven surfaces. On these particular tractors the L-shaped blades are designed so that the young plants are not smothered, even when the machine is travelling at three to four miles an hour. The tractor, being three-wheeled and having independent brakes on the two rear wheels, can be slewed round at the headlands in a remarkably short space. Yet another advantage is plenty of room between the blades and the central spindle, which allows the cut weeds to flow over the blades instead of choking between the ground and the frame.

Weed Spraying Control of weeds by acid spraying has been used in corn for some years, but in intensive market-garden crops the machinery has proved too clumsy and heavy, resulting in considerable damage to the crop. The fitting of a spray line pump and tank to these small tractors has opened a new field of progress of weed control in market-garden crops. The technique is to drill the crop and leave a mark to show the passage of the drill so that when acid spraying before the young plants show through, the tractor wheels run between the rows of seeds and not over them. The day for acid spraying has to be chosen carefully. The safest way is to examine the sowing daily, and to spray the field as soon as the crop is about ½ inch from the surface.

Crops such as onion, parsnip, carrot and others that are slow to germinate and break through the surface, are most suitable for this form of weed control, as most weeds are likely to appear first and thus be destroyed by the acid, but even with such quick-germinating crops as cabbage, it is amazing how much weed can be killed by this process. A very light covering of soil seems to give adequate protection to the young shoots about to break through, and 10–12 per cent sulphuric acid can safely be used. From the practical point of view there are difficulties, of course. For example, heavy rain about the time that the crop is due to break the surface means that the tractor may do damage by sinking into the soft ground; also a heavy shower of rain just after spraying may wash the acid off the weeds before it has a chance to kill them. In such cases it is necessary to fall back on hand workers if there are sufficient available.

With onions and young leek plants, the position is much easier; these crops can be sprayed after they have come up. Care must, however, be taken to see that they are not sprayed before the "knuckle" of the first spike has straightened itself. The disadvantage of a first spray at this time is that the weeds have reached the four- to six-leaf stage and it is difficult to make the acid strong enough to kill them without damaging the onion or leek crop.

It is possible with these crops to control all the weeds by three or four or even more acid sprayings and with no hoeing. I saw an experiment carried out by a commercial grower last year which showed a slightly better crop of onions where the weeds had been controlled entirely by acid spraying than where they had been hoed. It was interesting to note that where two hoe blades had inadvertently been let down, weed seed apparently brought

to the surface by the blades had germinated in such profusion that the acid had been unable to control them, but where the soil had been left undisturbed only a few weeds had come up and these had been effectively controlled by the acid spray.

Future Possibilities There seems little doubt that in the near future these small tractors will have many fresh attachments, especially for harvesting crops, and they will prove a most useful asset to market gardeners the world over. Their success appears to be due to their general handiness, good vision for the operator, and the system of putting the different tools into the same power and driving unit.

These developments for ploughing and cultivation and for intensive drilling and weed control work well in most conditions. They should lead to the increased production of vegetables and greater output per man-hour for workers engaged in the industry. They mark an important advance in the development of horticultural machinery and are recapturing for the country the lead it appeared to have lost both in the design and manufacture of this type of machinery.

PROPRIETARY PRODUCTS FOR THE CONTROL OF PLANT PESTS AND DISEASES

The Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland are now prepared to receive applications for the official approval of proprietary DNC-petroleum oil winter washes, calomel, 4 per cent calomel dusts, slug baits based on metaldehyde, banding greases and prepared grease bands.

Other groups in which applications have so far been invited are given in *Agriculture* ***51***, 402 ; ***52***, 47, 527 ; ***53***, 414. Application forms may be obtained from the Secretary of the Advisory Committee, Plant Pathology Laboratory, Milton Road, Harpenden, Herts.

"AGRICULTURE" INDEX

The Index to Volume LIV will be issued with the April number.

INCENTIVES

CLYDE HIGGS
Stratford-on-Avon, Warwickshire

GEORGE NICHOLLS, in 1847, wrote a prize essay for the Royal Agricultural Society entitled "On the Condition of the Agricultural Labourer; with suggestion for its Improvement". His main ideas were to increase the demand for labour by enlarging the field of its application. He thought that the agricultural production of England might be increased one-third by the use of more capital and more labour. He wished also for better education facilities. I cannot help quoting him: "The skilled labour now required is for the most part limited to mere manual skill in the common everyday operations of the farm—in ploughing, fencing, threshing and so forth; but agriculture will not always be conducted as at present". Then he wanted comfortable cottages, much in advance of the ruling standard, and finally cottage gardens, not solely for what they could produce but as a place of relaxation for a man and his family—the "flicks" and football pools had yet to come. That was one hundred years ago. The problem still remains, and I should be the last to imagine that this article will go very far towards finding a solution to it. I only wish I knew an answer to the problem, for most of my farming difficulties would disappear with it!

One more short quotation from Mr. Nicholls and I leave him: "It is only from the profits of labour that the fund for the payment of wages can be permanently obtained." True then, true now, true always; it is a fundamental fact in every industry, yet one that is so often ignored. Remunerative prices and adequate markets may be maintained temporarily by government action, but in the long run they frequently depend on the individual efforts of the employers and workers. The farmer, regardless of the size of his holding, has sufficient incentive to work well from the capital he has invested in his land. Efforts vary, of course, and there are still some farmers who are satisfied with just that level of production which is sufficient only to keep their heads above water.

Times Have Changed In the old days the worker had no interest outside his job. My first wagoner, intensely proud of his horses, was always on parade at five o'clock, although he was not due to start before six thirty! He cared nothing about overtime. He was well satisfied with a fixed sum to cover all hours, and a bit of rabbiting on Boxing Day. Another faithful worker, a hay tier, who, eschewing baths, carried the fragrance of his calling with him, was happy to truss hay at 7s. 6d. a ton. This figure included everything. He worked single-handed, making his own bands, stacking and sheeting the hay. It was a poor day when he did not do 90 half-hundredweight trusses. He cycled the twelve miles to and from the farm daily and indeed often spent the night in an outhouse after being locked out by his "managing" wife. In contrast today we use a baler driven by an engine, six men feed it and the output is much the same.

Times have changed; higher wages, comparable with those in the towns (often better when perquisites are considered), coupled with short working hours, have left the workers with ample leisure, and many of them, with the feeling that in a seller's market they need not exert themselves to the full. This feeling has been accentuated by the stress of war which made the production of food at any cost the all-important matter. The introduction of casual, unskilled and prisoner-of-war labour has lowered the standard of work of our permanent workers. It is difficult to convince them that

their duty demands a full day's work whilst they see others taking things easy. The present world food shortage may be far from temporary, and with the continued rise in living standards in those countries that previously were satisfied with so little, there may never again be gigantic food surpluses. Even so, consumers will buy in the cheapest market whenever they can.

Interest in the Job How then shall employers offer such inducements as will encourage farm workers to exert their maximum efforts? In factories it is a simple matter to pay bonuses either on individual production or spread over the whole concern. Continuous costing of repetition work carried out under known conditions independent of weather is easy. We can adopt piece-work methods for specialized jobs, particularly on those farms with long tradition and experience, where the workers are fully skilled and most likely descended from generations of the farming class. Root cultivation, sprout picking, potato harvesting, etc., all lend themselves to the piece-work incentive. But what of the mixed general farms, typical of England, where the employees must be Jacks of all trades and where, if we are to increase production, there will be many new entrants? How can labour on these farms be stimulated to greater effort? Is money the only reward?

An incentive need by no means be a monetary reward. My dog, Spot, in his normal travels gets along at five miles an hour; for his daily burst with the incentive of a car to run beside, he manages four times the speed! Encouragement in doing a job can come from knowledge as to why it is being done. Real drudgery can be lightened if the reason for it is fully understood. The smallholder knows why he is doing certain work and, being closely associated with any casual worker, will inform him. The farmer employing more labour could well call his workers together periodically to discuss past disappointments and future hopes. In this way the men feel that they have a personal interest in the work, and the small amount of time spent in discussion is more often than not amply repaid by increased output.

There is room for considerable improvement in the training of young farm workers. "Picking up the job" is all very well, provided the tutor is competent. Many a potential farm worker has been ruined by his early training. With the ever-increasing complications of farming methods, technical knowledge becomes more and more essential. As scattered as our industry is, it is not impossible to arrange evening continuation classes at suitable centres, although possibly after a day's manual work, workers cannot give full attention to such training. The alternative is to release them from daily duties to attend instruction, and undoubtedly this would be well repaid. The greater mechanization of our farms demands skill in both farming and machinery. Tractor drivers, for instance, would doubtless handle the machine with more consideration and do better work if they were properly trained and had some knowledge of the machine's inside. I know of some farms where workers are invited to invest capital in the undertaking. One in particular has registered a small company of which the capital formed a first charge on the farmer's assets. He guarantees the interest and pays a bonus if results warrant it. There are no restrictions as to investment, and withdrawals can be made at any time. Share certificates are not issued for less than £10, although some employees arrange for small regular deductions to be made from their wages, the certificates being made out as each £10 accumulates. On that farm the average holding is £150, withdrawals are very rare, and the workers have a real share in the business.

Rural Amenities, Education and Housing I made inquiries in one village as to why the young people were reluctant to work on the land, preferring factory life with town dwelling. The general opinion was that they had no objections to farm work as such but rather that the village lacked social activities in which they could take part on level terms. I do not include the public house. Radio has widened the mental horizon of farm workers. The days are gone when the men were satisfied only to sing in the local choir and take part in the annual outing. The lack of amenities in so many villages has an unsettling effect on prospective farm workers. Similarly, with education, the first question almost invariably asked by a married prospective employee is the distance from the school.

Perhaps the greatest incentive of all for farm workers—and most other workers as well—is a good house. Inevitably it will be some time before everyone can be properly housed, for not only are new houses necessary but much reconditioning needs to be done in our rural slums. Tied houses are not generally popular, although at present there is no alternative. When more houses are available, the need for tied houses will diminish automatically. The farming barometer may flicker, but in general it is set fair and that very stability will act as the chief incentive both in attracting labour to the land and retaining it.

THE SCOPE OF THE FILM IN AGRICULTURE

George Goodman, M.B.E.
Ministry of Agriculture and Fisheries

Paper read at the Conference on Films in Agriculture organized by the Scientific Film Association, January 17, 1948

I AM not a scientist. Nor am I an agriculturist; not even a gardener. And never have I laboured under the illusion that, if only some kind person would lend me a camera and a can or two of film stock, I could present the world with the film that would cure most of its ills. You may therefore wonder why your organizers invited me to submit a paper for your consideration. The answer is that the Ministry of Agriculture and Fisheries have long been in the film-using business. In 1916 we were recruiting a Women's Land Army by film; we were attempting to reduce potato losses from Blight by a film that sought to exploit the words of George Robey in its final caption "Let us spray"; and, as one of the Department's chief war-time activities was the provision of horses for the cavalry, our major scientific production was "Mange in Horses". Between the wars a long succession of silent and sound films tackled the problems of agricultural marketing; films for farmers designed to improve grading and packing, and films for the public extolling the National Mark. Our films were produced by the simple method of writing a shooting script in the Department, listing visuals, and writing a commentary; putting the job out to tender, and paying the bill—on receipt of negative and prints a few months later.

Today the Department is responsible for some 60–70 current films, and nothing, nothing is simple any longer about their making. It is the function of my colleagues and I who are concerned with Advisory Aids, to act as the centre of a triangle whose three sides are the scientist, the farmer, and the film maker.

Varying Pattern of British Farming In considering the question of the scope of the film in agriculture we should first view the immense diversity of food production. As an illustration, from Britain alone, I cannot do better than quote from the imaginary journey by air from Yarmouth to Barmouth described by Venn in his *Foundations of Agricultural Economics* (1933).

> One first traverses those coastal marshes, which, for two centuries, have fattened cattle as it is claimed no other district can do; then, after getting, to the North, a glimpse of the famous Broads area, devoted to the new industry of blackcurrant and raspberry production, one sees, in the heart of Norfolk, arable land irrevocably associated with barley and sheep. The soil changes again, and we are over those sandy brecklands, which, once credited with an agricultural output confined to rabbits and rye, are now the scene of great activities on the part of the Forestry Commission—in the production of yet another form of primary commodity.
>
> The next transition is a sudden one, for we quickly find ourselves over the most fertile and valuable agricultural land in these islands—the fens—and see in turn below us square miles of fruit (mainly of the "soft" varieties), of vegetables, and of flower bulbs reminiscent of Holland, while, as far as the eye can reach, the heaviest crops of cereals and of roots are also raised, as well as vast quantities of potatoes and much sugar beet. Crossing the river Nene we have, to our right, the Lincolnshire wolds with their flocks of grazing sheep, and below us the backbone of England, the outcrop of jurassic rock that, from Dorset to the Yorkshire coast, determines soil and, therefore, not only the distribution of crops and of livestock, but that of the lesser life, e.g., insects.
>
> For the next fifty miles we fly across the "Shires," which, oblivious of past times, when cereal prices were remunerative, nowadays provide pasture for countless thousands of beasts. Over Staffordshire we find ourselves surveying the activities of large numbers of relatively small milk-raising farms, whose produce is conveyed as far as London, and, if the day be clear, we see, far to the South, the Vale of Evesham, famous for its hard fruit, nor can we fail to observe the great number of poultry farms in this area. The Lowlands of Wales, devoted to pasture, give place to its mountains, with their flocks of hill sheep, and we finally sight the sea again above the arable fields of Cardigan Bay. Who would claim that those numerous and diverse forms of crop and of animal husbandry represent anything but separate industries?

The picture today would be even more diverse—less grass, fewer haystacks, fewer bulbs—more corn and new crops like kale, flax and linseed. And potatoes everywhere. More cows but fewer sheep.

Each holding in this infinite variety presents its own technical problems. Every crop and every form of stock have to endure constant biological aggression—by weeds, by insects, fungi, bacteria and viruses. And no two units present identical features of soil; even within a single field soil heterogeneity is frequently evident within a few square yards. This unending diversity has in fact been responsible for a valuable contribution to scientific method, since it was the difficulties of dealing with agricultural sampling and investigation that led to the development of modern statistical analysis.

All of these technical problems seek scientific aid in their solution, and already a great body of scientific fact relative to agriculture is available, and the output of added knowledge is almost overwhelming to any agricultural librarian. For example, one bibliography of agriculture lists seven to eight thousand items every month. Meanwhile research goes on in practically every country in the world. In Britain alone over one thousand agricultural research projects are being conducted at the present time, not counting those undertaken by commercial bodies. In soil research the physicists are down to such fundamentals as the electric charges on clay particles and organic matter colloids; the bacteriologists are, among many other things, concerned with micro-flora and the legume nodules and their bacteria that play so important a role in soil fertility; the chemists' investigations range from lime content to the trace elements; the engineers endeavour to take away the waters on the one hand and put them back somewhere else on the other; and they devise implements that shall make the soil

STILLS FROM SIX AGRICULTURAL FILMS


World of Plenty


Crown of the Year

Spring on the Farm

Grassy Shires


LINSEED (See pages 535-8)

[Photo, *Farmer and Stockbreeder*

A good crop of linseed on the Guiness Dairy Farms, Old Woking, Surrey.

[Photo, *Aero Pictorial*

An aerial photograph showing the general situation of Mr. F. W. Burmann's farms near Amersham, Bucks. Note the three fields marked A, B and C, referred to in his article.

MACHINERY FOR MARKET GARDENING (See pages 549-52)

Hoeing seedlings (17-inch rows)

Cultivator with hydraulic lift

fit the needs of the plant. These are but a hundredth part of the research that proceeds on the soil alone.

The plant world finds the geneticist allied to the plant-breeder—part scientist, part artist—in their basic quest for higher yields combined with such things as resistance to disease or pests in wheat and oats or a higher malting quality in barley, higher sugar content in beet, earlier ripening in beans and higher protein in grasses. Again, this is but a small part of the work in progress.

Then there is livestock. Things have changed greatly since 1904, when William Bateson, addressing the Zoological Section of the British Association, could say, "Breeding is the greatest industry to which science has never yet been applied". Today the animal geneticist is very closely concerned with such homely and comforting matters as more milk, more beef, more eggs, more bacon and more mutton, but his way lies through such mysteries as the molecular structure of genes and the chemical organization of the chromosomes.

Important research is also being undertaken on animal nutrition (even the geneticists have not yet evolved an animal without a stomach), and on the veterinary side activity is almost as wide and as varied as in medicine itself, as well it might be—our losses from animal disease have been variously estimated at 19 or 20 million pounds per annum.

These are but haphazard examples. I have omitted the entomologists, the plant pathologists, the animal husbandry specialists, the agronomists, the endocrinologists, and many others. The list embraces every science bar one—astronomy—but the agricultural meteorologists may yet bring that in. And there is a school that thinks we should pay rather more attention to the moon. And the nuclear physicists are in—only last month they held a Conference at Oak Ridge on the use of their isotopes in agricultural research.

The Film and the Farmer This rapid survey presents but one side of the triangle. What of the second side—the farmer—the technical film's audience? How does he stand in relation to this great wealth of science?

First of all, farming is not in practice, and never will be, a science. There are too many variables, too much that is unpredictable; the soil is too heterogeneous; and animals, as you find when you come to handle them day after day, are very much individuals.

Nor, despite soilless culture and battery poultry-keeping, is the farm a factory. In the last resort, it is, as in the time of Virgil, "hope that sustains the farmer," not the report from a test bench, not the laboratory experiment nor the findings from a pilot plant.

No, farming is largely an art, to be learnt primarily by observation and experience, based in part on tradition. And it is a business—a complex difficult and still highly speculative business. But because it is neither science nor run on factory lines, this is not to say that it is inefficient—at least throughout most of Britain. It would be a most remarkable industrial plant (and very remarkable scientists who created it) that worked day and night seven days a week for 4,000 years and at the end was giving more per unit of a better product with less labour than at any period of its history! But that is just what the soil of this country has done, nursed and tended by generations of its farmers. That is what tradition means to farming. We must remember that soil, wherever it is found, is rock material on its way

down to the sea, and that the preservation of its food-giving value depends on the efficiency of the means by which man keeps that passage down to a rate no greater than the decay of the material on which it temporarily rests In farming, one generation can condemn many that come after to a lower standard of living. Let me quote from that great film *The River* by Pare Lorentz:

> And the planters brought their blacks and their ploughs . . . corn and oak down the Missouri to Baton Rouge . . . tobacco down the Ohio, down from Pittsburgh, down from St. Louis . . . hemp and potatoes, corn and flour . . . we made cotton Kings . . . we rolled a million bales down the River . . . four million bales—down the River . . . rolled them over Alabama, rolled them off Mississippi, rolled them off Louisiana . . . we mined the soil for cotton . . . and then moved west . . . there was lumber in the north . . . we cut the top off Minnesota and sent it down the River . . . we cut the top off Wisconsin and sent it down the River . . . we ploughed for corn . . . and moved on when the land gave out . . . and 400 million tons . . . 400 million tons of our most valuable natural resource have been washed into the Gulf of Mexico every year . . . and poor land makes poor people . . . poor people make poor land.

It hasn't happened here: there was and is a tradition.

Science applied by the farmer has played its part—a large part—but let us not forget that it was the art of the hand and eye of the animal breeder, not his biological degree, that produced the *dairy* cow, the *beef* bullock, the *egg-teeming* hen, and the *quick-fattening* pig. They were pre-Mendel men. And long before Rothamsted our soils were given phosphates by the practice of boning; long before *p*H values were known our fields were limed.

But, while claiming much for the virtues of tradition and craft and the application of science so far, it must be admitted that the revolution in British farming demanded by the war revealed that there was, in some parts of the country, much ignorance of the principles and practice of good husbandry. In the districts which for a generation and more had been down to grass, the knowledge of arable practice had been lost. And throughout the whole country our farmers have had to learn to grow the feeding-stuffs that war and the world shortage have denied us.

There is still much to be done in the promulgation of sound farming methods and in raising the overall efficiency, and if, as seems certain, our farming is not again to be grassbound, and our soil is to give us all the milk, much of the beef and mutton, bacon and eggs and the vegetables and fruit we shall need to give our people an adequate diet, a mighty task lies before those on whom is lain the responsibility for the technical improvement of our farming. And great opportunities await the makers of the films that shall aid them. But the films must be made to fit the job.

The farmer today is willing to accept and use more of science than ever before. His business ability prompts him, but, what is more important, science is not being rammed down his throat; the results of research are being passed through the test of practical farming before being recommended.

But beyond this there is a marked desire to know the "how" and "why" behind things, and in the sphere of films it has been those productions that dealt with the "how" and the "why" without either condesension or academic aloofness that have proved most successful. The film has a great part to play in this technical field—and it is not a narrow field; much of it is international. For example, the film *The Science of Milk Production*, made in America, and shown for the past two years in this country, is being used in New Zealand, Australia, the Netherlands, and Switzerland.

In this rapid survey I have attempted to indicate the scope of the film in agriculture by reference to the many sciences involved, which must

determine content, and by showing something of the farmer—who, with his men, his sons and daughters, and the students of colleges and farm institutes, will comprise the audience.

I have not dealt with the third side of the triangle—the makers of films—All I will say is "they vary". But they are here today; and Mr. Anstey will be speaking of their problems. I may say that, sitting at the centre of the triangle, I do appreciate these problems.

Agriculture in Social Consciousness So far I have confined myself to the technical field. Greater problems perhaps lie within the realm of sociology, and arise from the simple fact that the primary producer expects that in return for his skill and labour he shall be fed, clothed, given shelter and live the life of other men. There are two aspects of the matter—food and agriculture. First, the food problem—all too familiar to the poor of the world. Even in normal times, before the devastation of war, more than 1,000 million people (I quote Sir John Boyd Orr)—half the population of the world—suffered from disease, physical disabilities and premature death due to the lack of adequate food.

The agricultural aspect is all too well known to every farmer over the age of 35. After the 1914–18 war huge surpluses of food accumulated: prices fell below the cost of production; farmers everywhere were ruined; land went out of cultivation; families who had spent their lives raising food went hungry to the towns to swell the lines of unemployed. About this time Sir Daniel Hall wrote:

> The man of science must take up an apologetic attitude at the present time with regard to agriculture. For two generations he has been entreated to make the land more productive and to reduce costs, but as an American professor of agriculture writes to me: "Ten million acres of cotton and some thousands of tobacco have been ploughed under. The latest move is the killing of some 5 million pigs weighing under 100 lb. and the slaughter of some 200,000 prospective mother sows. If this will bring national prosperity I have wasted my life." The man of science may be forgiven if he concludes that he is no longer wanted and may retire to his ivory tower, but whatever food for irony the world spectacle presents he will not be allowed to enjoy it in detachment, for if the deluge comes he will be swept down with the rest.

This was not just that old bogy "Poverty in the midst of plenty". Even without these insanities, even if the surpluses could have been distributed, there would still not have been enough. Today we know that by the dissemination and application of science the food can be grown. But can the world—the urban world—the industrialists, the politicians, the people themselves, even the starving people, be made ready to receive that food?—be persuaded of its *real* value?

Time has shown how dearly bought was that "cheap" food of the last half century or so—at the cost of world-spread erosion—"400 million tons of earth down to the Gulf of Mexico every year". Precious soil, enslaved, exploited and thrown away—not in one continent but in all.

Nothing can equal the film as a medium for making the non-rural audience aware of its close and vital relationship to the primary producer. It has been one of the most satisfying experiences of my official activities to have been associated with two series of films—*Winter–Spring–Summer on the Farm*, and *The Crown of the Year*, and *The Pattern of Britain* group—films which eschewed the romantic and picturesque attitude that too many of our writers and essayists found profitable. Their directors served our agriculture well.

On the wider canvas we have had some great films touching the social aspects of food and agriculture—Lorentz's *The Plow that Broke the Plains*, and *The River*, Flaherty's *The Land*, John Ford's *Grapes of Wrath*, Rotha's *World of Plenty* and *The World is Rich*.

But much remains to be done. Let us all beware of a false complacency, imagining that something called F.A.O. can do it all—F.A.O. can find the facts. F.A.O. can stimulate the dissemination of the sciences applicable to food production. But, in the end it will be the audiences in the cinemas who will resolve the problem. And in their decision lies not only "freedom from want" but freedom from war, for, in the ultimate, wars and revolutions are the end-products of hunger or the fear of hunger.

"The worth of men", said the late A. N. Whitehead, "consists in their liability to persuasion" ! In this persuasion—applied in the fields of technique and of social adjustment—lies the scope of the film in agriculture.

THE CENTRAL FILM LIBRARY AND C.O.I. MOBILE FILM UNITS

ARTHUR VESSELO
Secretary, Central Film Library

THE Central Film Library is the biggest distributor of agricultural films in this country. In its present form, it was set up by the Ministry (now the Central Office) of Information at the beginning of the late war, but it incorporates also the pre-war Empire and G.P.O. Film Libraries, which date back to the early 'thirties. The original Empire Film Library was created as a distribution channel for the films of the old Empire Marketing Board, which will be remembered as the sponsor of John Grierson's famous silent film of the North Sea herring-fleet "Drifters". There is thus a close connection with the birth of the British documentary movement.

Out of 850 or so titles in the Central Film Library's catalogues, nearly 150 are on agricultural subjects, and there are an additional 20 or so on horticultural and allied subjects. The great majority of these are sound films, and available in either 35 mm. or 16 mm. size. The silent films are 16 mm. only. The nucleus of the collection, including the horticultural subjects, is a group of some 70 Government-sponsored films (mostly made by the Ministry or Central Office of Information for the Ministry of Agriculture). The remainder, all specially selected, derive from various outside sources, such as Dominions Governments, Imperial Chemical Industries, Shell Chemicals, and so on, and have usually been acquired under the sponsorship of the Ministry of Agriculture.

In subject-matter the films cover the widest possible field, from the straightforward instructional film of the type of "Stomach Worms in Sheep" and "Lifting your Potatoes" to the global survey documentary type exemplified by Paul Rotha's "World of Plenty". Somewhere between the two come the extremely popular "Pattern of Britain" series and other films like them.

The Central Film Library is a purely non-theatrical body and does not lend films for ordinary public showing in cinemas or for any showings to which an admission charge is made. Films are, however, readily available

for loan to any approved organization having its own projector and experienced projectionist, providing a reasonable-sized audience, and making no charge for admission. Under present conditions loan is free, except that borrowers must pay return carriage. Application forms may be obtained on request from the Central Film Library, Imperial Institute, London, S.W.7. A complete up-to-date catalogue of all films in the Library is in the press and will shortly be available, price 2s. per copy.

Branch Libraries and C.O.I. Regional Offices In addition to the Central Film Library, there are three branch Libraries, in Scotland (2 Newton Place, Glasgow, C.3), Wales (2 Cathedral Road, Cardiff), and the South-West (at the moment at Dartington Hall, Totnes, but from April 1, 1948, at 15 Belgrave Road, Bristol, 8). Local borrowers should apply direct to these Libraries for 16 mm. films, but to London for 35 mm. films.

For organizations not having their own projectors a separate and self-contained service is provided through the Central Office of Information Regional Offices. There are twelve such Offices, in all parts of the United Kingdom, and at each Office there is stationed a Regional Film Officer, who has a stock of films and a number of fully equipped mobile units at his disposal and can thus supply (free of charge) programmes of films, projectors and projectionists to those requiring them for approved purposes. In such cases applications for programmes should *not* be made to any of the Libraries, but to the appropriate Regional Officer (whose address can be obtained from the Central Office of Information, 83 Baker Street, London, W.1, or from one of the Libraries). Free pamphlets giving more detailed information about the mobile unit service, including a selected list of agricultural films available for showing, are also obtainable from the Regional Offices.

NEW METHODS OF MILKING

Professor W. E. Petersen,
University of Minnesota
and
John Green

Summary of B.B.C. Broadcast, Home Service, December 4, 1947

AT the conclusion of a very successful tour during which he has lectured up and down the country to thousands of farmers on improved milking methods, Professor Petersen was invited by John Green to restate for the benefit of those who had been unable to attend the lectures, his cardinal rules for good milking.

There are five of them, said Professor Petersen :

(1) The cow must be at ease at milking time, undisturbed and unexcited.

(2) She should be stimulated to let down her milk about one minute before milking is to begin.

(3) The milking machine must be in good working order and operated according to the manufacturers' directions. With hand milking, the broad surface of the hand should be applied.

(4) In machine milking, the whole of the milk should be extracted by the machine. The hands should not be used at any stage.

(5) The teat cups must be removed as soon as the milk ceases to flow.

Enlarging on these points, Professor Petersen said that "let-down" requires the cooperation of the cow. Any excitement, pleasurable or otherwise, will prevent response to the milking stimulus; the milk will not be let out of the little recesses—alveoli—in which it is stored. The most effective stimulus is massage of the udder with a cloth wrung out of warm water just about a minute before milking is to begin. This is the nearest practicable approach to the calf's nursing action; the calf applies a warm, moist mouth, so stimulating the nerve endings.

As regards machines, many are in a faulty condition. There may be leaks in the pipe lines, vacuum guages out of order, or distorted rubber linings in the teat cups. In hand milking the idea of the broad hand is to avoid injury to the delicate linings on the inside of the teat. Over-vigorous stripping with the finger tips is likewise harmful. Indeed Professor Petersen is opposed to hand stripping altogether, and for three reasons: (1) it involves extra work; (2) sooner or later the cow will come to depend on stripping for her let-down, and (3) it leads to some contamination of the milk.

Every drop of milk can be obtained by proper manipulation of the teat cups. As milking progresses more of the tissue is drawn into the teat cup, and the passage-way for the milk from the udder is pinched off. By lowering the teat cups and massaging the udder, the passages are re-opened, all the milk is let down and can be obtained by the machine.

Lastly, so long as the milk continues to flow the milking machine exerts no force on the inside of the teat, but immediately the milk stops the vacuum enters the teat with damaging effects. The machine must therefore be removed as soon as the flow ceases.

Professor Petersen denied that he had ever said that every cow could be milked in three minutes. The cow must be treated as an individual.

American and British Conditions Compared

Asked by Mr. Green what he thought of our dairying, he said that we, like farmers in America, were inclined to apologize for the low average production. The average yield is just about the same in both countries, and "it's too low for the most economic production". He added that there are fewer dairy breeds in America. In the dairy shows, for instance, only five breeds—Friesians, Jerseys, Guernseys, Brown Swiss, and Ayrshires, are admissible. There are some dual-purpose breeds as well but they are not eligible for entry to the dairy shows.

As regards feeding, Professor Petersen said that, compared with America, our pastures are vastly superior. Feeding is an aspect of dairying to which Americans had not given nearly enough attention. He was particularly impressed with the ley system in this country, but thought we could make greater use of grass for winter feeding.

"As a matter of fact, I think it's a solution of your protein shortage problem."

Grass silage would be specially helpful in this connection and, in some cases, drying also. In America maize is the chief silage material, and there are few livestock farms without a silo.

About labour and management in England, he thought that dairy labour is not as productive as on most farms in America, and this he attributed to our ancient buildings, which were intended originally not for dairying but for bullock fattening

In the northern states of America and in Canada hay is stored on the

upper floor of the cowshed and is let down by gravity. This saves labour and the hay overhead helps to keep the byre warm in the severe N. American winters.

Asked as to the actual amount of labour a man can accomplish, he instanced, as an extreme case, the contract system in Southern California under which 60 cows are machine milked by one man twice a day. He starts at five a.m. and milks till nine o'clock, then again from five to nine o'clock at night. In addition he feeds the grain and cleans out the byre; all the utensils are washed for him. For this he receives 300 dollars a month (£75).

Green: "He's getting as good an industrial wage as anybody in the country."

Petersen: "That's right, but note the amount of work that he's turning out."

Everything, he explained, is adapted for the most efficient use of labour. Buildings are constructed with that end in view, and the milking job is systematized.

THE LEEK MOTH

S. G. JARY, B.A., S. W. H. ROLFE, B.Sc. and K. CARPENTER, B.A.
National Agricultural Advisory Service, South-East Sub-Centre, Wye, Kent

A BRIEF account of the occurrence of the leek moth in England was published in this JOURNAL in April, 1945. The present article summarizes information subsequently obtained concerning the life history of this insect and describes experimental work carried out on its control by means of insecticides.

Life History It seems probable that three generations of the moth occur annually in the South of England, though in exceptionally favourable seasons there may be a partial fourth generation.

Hibernation takes place in the adult stage, the moths probably concealing themselves in any suitable shelter, e.g., beneath loose bark or in sheds and other buildings. No moths have actually been found during the winter, but under laboratory conditions they invariably hibernate in that stage. All chrysalides of the last generation found in the field give rise to moths during the autumn, and caterpillars have never been found in plants during the winter.

FIRST GENERATION The moths emerge from hibernation in early spring, but this emergence may extend over a considerable period. The first eggs were found in the field during mid-April and egg-laying continues at least throughout that month. Overwintered plants of leek, perennial onions and garlic are commonly chosen for this purpose, and some eggs may be laid on shallots. The eggs are minute, very broadly oval and slightly iridescent. Evidence of attack by the caterpillars is seldom seen until the second week of May, except perhaps in very sheltered situations.

SECOND GENERATION The earliest moths of the second generation appear during the latter part of June and become most numerous about the end of the month. Emergence seems to take place over a considerable period and egg-laying continues throughout the first three weeks of July or possibly longer. From the middle of July onwards, attacks develop on seedling leek plants and may be sufficiently heavy to cause serious injury or even render the plants useless. In early August the caterpillars are fully grown and form chrysalides, surrounded by a delicate cocoon, on the outer leaves of the plants, especially upon dead tissue.

THIRD GENERATION Moths of the third generation emerge from mid-August onwards and lay eggs upon leek and other plants, including those producing seed heads. As a rule the caterpillars are more numerous than those of the previous generations, and damage at this period is consequently more severe than at any other time. Not only may leek plants be so badly injured as to be useless, but damage to the stems of seed plants is sometimes so great that the tip of the stem becomes honeycombed with tunnels and the seed head falls to pieces. When fully grown the caterpillars form chrysalides on the outside leaves of the plants, or, on seed plants, among the stalks of the seed head itself.

Moths emerge during the latter part of October and early November. They may occasionally be found among the seed heads, but appear to leave them and seek other quarters for hibernation when suitable weather occurs. These moths live throughout the winter and constitute the first generation of the following spring.

Control Measure Trials, 1946 In 1945 a series of preliminary experiments was carried out at New Romney, Peacehaven, and Eastbourne, to obtain some information on the possible value of a number of insecticides. The insecticides used were benzene hexachloride, DDT and nicotine, each in dust and spray form. Details of the results obtained in 1945 are not included here. They suggested that benzene hexachloride afforded little, if any, protection from attack ; indeed it was liable to cause severe injury to plants. Nicotine appeared to be of some value but was less effective than DDT.

The 1946 trials were carried out on an allotment at New Romney. Leek seed was sown in widely spaced rows on April 15, and seedlings were well through the ground on May 20. The plants for seed were set out on May 2. The insecticides tested were :

1. DDT dust containing 5 per cent commercial DDT.
2. DDT emulsion. The spray applied contained 0.1 per cent commercial DDT.
3. Benzene hexachloride dust, containing 3.5 per cent commercial benzene hexachloride.
4. Benzene hexachloride suspension. The spray applied contained 0.2 per cent commercial benzene hexachloride.
5. Nicotine dust, a proprietary brand containing 3 per cent nicotine.
6. Nicotine spray fluid, containing 0.05 per cent nicotine (98 per cent).

Each treated plot consisted of two rows of seedlings, each row about 5 yards in length, and one row of eleven widely spaced plants set out for seed production. There was also an untreated area twice the size, but part of this was subsequently treated as described later.

Attack in New Romney Area, 1946 No evidence was obtained of the time of appearance of the moths from hibernation at New Romney. At Hythe, about 8 miles away, eggs were found on garlic plants in a sheltered nursery on April 23 and on leek seedlings on April 30. On the more exposed New Romney site no eggs were found on the seed plants up to May 20, the date on which the seedlings were well through. Treatments (1) and (3), DDT dust and benzene hexachloride dust, were applied on May 20 to their respective plots, in the expectation that some attack might occur. Weather conditions, however, remained very adverse. With the exception of a very slight attack on a few of the seed plants, there was nothing to indicate that egg-laying had occurred up to June 7, at which date all the plots received their respective treatments. Up to July 7 no attack occurred, indicating that the overwintered moths were very few on this site and that the first generation attack was virtually absent. On July 22 a very small amount of fresh larval injury was found on both the seedlings and flower heads, suggesting that eggs had been laid by moths of the second generation. All treatments were again applied on July 23 and repeated on July 31.

The second generation attack, however, failed to develop. Examination at intervals up to August 23 revealed no injury to the untreated plants and, for all practical purposes, injury was insignificant up to this date. On August 26 eggs were found in moderate numbers, evidently indicating the emergence of moths of the third generation. All plots were again treated on August 27 and the applications repeated on September 5, though no further evidence of egg-laying was seen. From eggs laid by these moths a moderately severe attack developed, sufficient to cause appreciable injury to the plants but considerably less destructive than attacks observed in 1943 and 1944. The first fresh moth was seen in the field on October 25.

TRIAL 1

First treatment	..	August 27
Second treatment	..	September 5
Results estimated	..	September 21

Prior to August 27, the attack on all plots had been extremely slight. All new leaves arising from the middle of the plants were entirely undamaged and the plants were making rapid growth. The early signs of attack are most evident on the young foliage and, in estimating the effect of the treatments, the new leaves only were examined. For the estimation of results, four random groups of ten plants were taken in each treatment and also in the untreated plot.

Table 1

Plot	Treatment	Number of seedlings attacked per 10 plants four times repeated	Total number of plants damaged in 40
1	DDT dust	3 : 3 : 5 : 3	14
2	DDT spray	0 : 2 : 0 : 0	2
3	Benzene hexachloride dust	3 : 4 : 6 : 5	18
4	Benzene hexachloride spray	5 : 2 : 4 : 6	17
5	Nicotine dust	2 : 3 : 4 : 0	9
6	Nicotine spray	4 : 3 : 1 : 5	13
7	Untreated	5 : 7 : 6 : 4	22

On statistical examination of the results, (2) proved significantly better than any other treatment. All treatments except (3) and (4) were significantly better than the untreated plot. The failure of benzene hexachloride

to give any significant degree of control confirmed the preliminary indications obtained in 1945.

Trial 2

Table 1 shows that two treatments reduced the attack and that DDT spray was outstanding in this respect; although in all cases a few caterpillars remained. These caterpillars continued to cause some damage to the middle leaves of the plants and, in order to discover if further protection could be obtained, half of each plot was again treated on September 28. The caterpillars were then more than half grown. On October 8 the results of the third treatment were estimated in the same manner as before.

Table 2 shows the number of plants with *fresh* injury to the middle leaves on that date and compares the degree of control on plants treated twice with those treated three times. It is essential to remember that the figures indicate the *freshly* damaged plants; the figures for plants treated twice are therefore not necessarily identical with those shown in Table 1. They are a measure of the *continuance* of feeding, not of the total extent of injury.

Table 2

Plot	Treatment		Number of seedlings attacked per 10 plants, four times repeated	Total plants damaged in 40
1	DDT dust	(2 treatments)	3 : 1 : 2 : 6	12
		(3 ,,)	1 : 1 : 0 : 1	3
2	DDT spray	(2 ,,)	1 : 1 : 1 : 0	3
		(3 ,,)	0 : 0 : 0 : 0	0
3	Benzene hexachloride dust	(2 ,,)	3 : 4 : 5 : 3	15
		(3 ,,)	3 : 5 : 6 : 3	17
4	Benzene hexachloride spray	(2 ,,)	7 : 5 : 7 : 6	25
		(3 ,,)	9 : 9 : 6 : 6	30
5	Nicotine dust	(2 ,,)	5 : 4 : 8 : 6	23
		(3 ,,)	0 : 1 : 3 : 0	4
6	Nicotine spray	(2 ,,)	6 : 6 : 5 : 8	25
		(3 ,,)	6 : 5 : 4 : 7	22
7	Untreated		8 : 7 : 4 : 8	27

The following conclusions may be drawn from this trial:

1. In no instance did two treatments completely eradicate the attack. The number of attacked plants showing fresh damage on October 8 was very similar to that observed on September 21.

2. Benzene hexachloride was ineffective, and the failure of the third application is well marked.

3. The continuance of damage on plants receiving nicotine spray confirms that two applications only reduced the number of caterpillars to some extent. The third application had little beneficial effect.

4. As with nicotine spray, some caterpillars survived treatment with nicotine dust. This material, however, seems to have been fatal to a proportion of the caterpillars, since a third application brought about a further reduction of damage.

5. DDT dust produced some immediate reduction of attack, in the same way as nicotine dust.

6. DDT spray showed superiority over all other treatments. Not only did two applications afford a very high degree of protection, but the larger caterpillars were also affected by the third application.

Trial 3

On September 21 the untreated plants showed rather widespread, though not severe, damage, 22 of the 40 plants examined having been attacked. On September 27 two separate areas of hitherto untreated plants were treated with DDT spray and nicotine spray, in order to obtain some information about the extent to which fresh damage could be prevented on plants already being attacked. Table 3 shows the reduction of *fresh* injury brought about by one application on September 27. Results were estimated on October 8.

Table 3

Treatment	Number of seedlings attacked per 10 plants, four times repeated	Total plants damaged in 40
DDT spray	2 : 1 : 2 : 1	6
Nicotine spray	5 : 7 : 7 : 5	24
Untreated	8 : 7 : 4 : 8	27

This trial confirmed that DDT spray was effective in bringing about an immediate reduction in attack, even though the caterpillars were almost fully grown at the time of application. Nicotine spray was of little value in this respect.

Leek Seed Plants Overwintered leek plants for the production of seed heads were treated on August 27 and September 5 with the same insecticides as the seedling plants. Although the plants were staked and tied, very strong winds caused much damage and many flower stems were broken. On November 1, the seed heads remaining on each plot were cut and brought in for examination. The nature of damage caused to seed heads has been described in the previous article*. When caterpillars in the seed heads are fully grown in October, they bore out from the stem and spin a cocoon among the cluster of flower stalks forming the head. It is possible that a few leave the plant altogether, but it is certain that the very great majority remain in the head. By careful examination of the head, the cocoons are readily found, and by counting them, an estimate of the intensity of attack upon the seed heads can be made. Table 4 shows the number of cocoons found in this way.

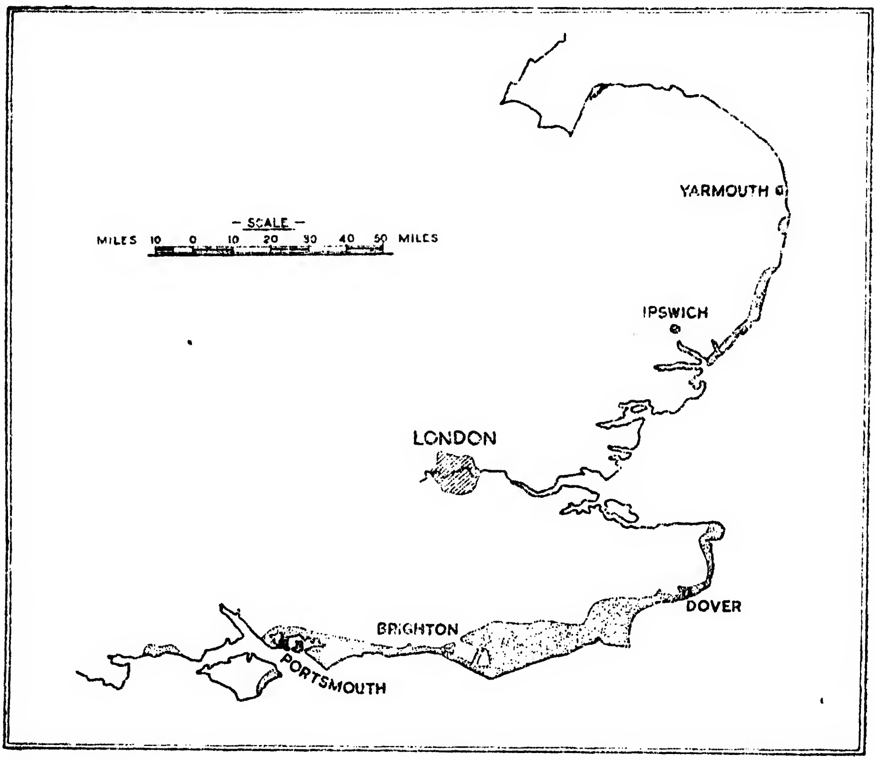
Table 4

Treatment	Number of heads harvested	Total number of cocoons	Average number of cocoons per head
DDT dust	8	7	0.9
DDT spray	8	5	0.6
Benzene hexachloride dust	7	39	5.6
Benzene hexachloride spray	4	30	7.5
Nicotine dust	6	25	4.2
Nicotine spray	5	7	1.4
Untreated	10	72	7.2

Although the number of seed heads available was comparatively small, the results, especially when considered together with those obtained from the seedling plants, indicate the following conclusions:

* *loc. cit.*

1. Benzene hexachloride affords little, if any, protection. Some injury to the plants was caused by this substance, especially when applied in the form of a spray, an effect also observed in 1945. Injury takes the form of a retarded growth, associated with a sickly and sometimes scorched condition of the foliage.
2. Nicotine dust was less satisfactory than on seedling plants. Possibly the amount of dust penetrating the dense flower heads was insufficient to permit any marked insecticidal action.
3. Nicotine spray appeared to be rather more effective than on seedling plants. This may be due to its tendency to run down towards the tip of the flowering stem, the point at which the caterpillars feed.
4. DDT dust and spray both gave a high degree of protection.



General Conclusions and Recommendations

The shaded coastal areas on the map of E. and S.E. England indicate the localities in which the moth is known to occur. Its presence has been reported from Gt. Yarmouth, Norwich and Mundesley, but these reports have not been confirmed.

The actual time of appearance of the various generations cannot be stated with certainty, but in those localities where the moth is known to occur at present, egg-laying may be expected at the following approximate periods :

First generation	mid-April—early May
Second ,, ...	late June—mid-July
Third ,, ...	mid-August onwards

Owing to the fact that some caterpillars take longer than others to become fully grown, late moths of the second generation in July may be present with early ones of the third generation in August, so that some eggs may be laid

at any time in the summer from late June onwards. In all probability, however, there are "peaks" of emergence when the moths are most abundant. They are very difficult to recognize in the field and casual observation cannot be relied upon to detect them.

At any time from early July onwards, as soon as the first sign of damage is seen, DDT dust or spray appears to offer a very good chance of protection. For most purposes it is probably more convenient to use the dust form, especially since the time and labour required for dust application are relatively small. By repeating the application at intervals of about two to three weeks, a high degree of control is likely to be achieved.

We should like to record our thanks to Mr. J. H. P. Sankey for his assistance in connection with the trials described. The E. Sussex W.A.E.C. and the New Romney Borough Council were good enough to provide facilities for work to be carried out on land under their jurisdiction and their co-operation is gratefully acknowledged.

COLORADO BEETLE IN JERSEY, 1947

T. Small, D.Sc., A.R.C.S.
States Mycologist, Jersey, Channel Islands

THE favourable beetle situation in Jersey in 1946, when only 36 adults were found, afforded grounds for hope that the Island would be almost, if not entirely, free from the pest in 1947. It is interesting to note, therefore, that in 1947 only 4 adults were found on the sites of the old outbreaks. This result shows that the measures taken to combat the widespread and heavy infestations of 1945 had been effective.

Unfortunately at the end of May, 1947, the Island experienced a new, heavy invasion of beetles, presumably from France. The results and experience gained in 1945 and 1946 proved invaluable in combating this new menace, and have engendered confidence in the outcome of the efforts to check the multiplication of the pest. The cost of the beetle campaign may be taken as a measure of the Island's determination to eradicate the outbreaks: in 1946 it was more than £40,000, and in 1947 it was at least £50,000, i.e., an average of nearly £1 per head of the population per year, equivalent to an expenditure of £47 millions in the United Kingdom.

1947 Invasion The first sign that something unusual was happening was noted on May 28 when two live beetles were found, one by a woman in a street in St. Helier and the other by schoolchildren on the beach at St. Aubin. During the next seven days no less than 386 live adults were discovered in all kinds of places, including gardens, fields, streets, roads, and beaches, and many thousands of dead ones were washed ashore. Single live beetles were found in a tub of rainwater, clinging to a boat 300 yards off-shore, crawling up the door of a house, on a hotel roof, and on each of three people—two on the beach and one in town. In three instances beetles thought to be dead when submitted for identification recovered next

day. From June 5 onwards far fewer finds were reported daily, and as the season progressed it became evident that most of the invaders had been destroyed or collected.

Within a few days of their arrival, the beetles found their way to the potato crops and began to lay eggs on them, thus showing that they were in a fertile condition. The first group of larvae, just hatched from the eggs, was discovered on June 9, and the second on June 18.

Pupae were first found on July 11 and 25. The first adults of the new generation were noted in the laboratory on July 14 and in the field on July 25; young beetles hatched in the laboratory on July 30 began to lay eggs two weeks later. The last finds of the season were eggs on July 28, larvae on August 25, pupae on July 25, and one adult on September 16.

It is of interest to note that one live beetle was found on the deck of S.S. "Brittany," when she docked in harbour in Jersey on May 22. Inquiries showed that the "Brittany" had sailed from Le Havre to Southampton and then on to Jersey.

Incidence of Live Adult Beetles The number of live beetles reported in 1947 was 742. Of these, 388 were found between May 28 and June 4, 209 between June 5 and June 30, 79 in July, 34 in August, and 32 in September. Finds of single beetles included 15 in the streets and gardens of St. Helier, 4 on country roads, 11 on beaches, and 86 in fields, especially those cropped with potatoes. Finds of from 2 to 6 beetles totalled 34. In each of nine rather serious cases 15 or more adults (the highest number being 49) were discovered on potatoes, but in seven of them nothing further was found after July 5, despite frequent inspection of the trap plants. Since the end of July only 7 old beetles have been recorded.

As already stated the first young adult found in the field was on July 25. Altogether 65 young adults were recorded, 6 in July, 27 in August and 32 in September. These finds occurred in eleven places, and in four of them a total of 46 beetles was found.

Incidence of Larvae The presence of larvae was confined to one or a few adjacent plants in thirteen cases, to less than one Jersey perch (one-ninetieth of an acre) in twenty-seven cases, to one to five perches in six cases, and in six cases the larvae were scattered throughout the crop. In the remaining seven attacks the larvae were present on volunteer potato plants among roots and other crops. One interesting feature of these discoveries was the presence of large larvae in some infested areas, yet apparently little feeding had taken place on the host plants.

Of fifty-nine larval cases, twenty-eight occurred in areas where adults had been collected earlier in the season, in twenty-eight of them larvae only were found, and in the remaining three cases both adults and larvae were present when the discovery was made.

Despite frequent inspection of the trap plants throughout the season, no further finds were reported after the end of July from forty-nine of the larval outbreaks. Experience suggests that in many of these areas no recurrence of the pest is likely in 1948.

Incidence of Infestations On the days immediately following the invasion the discoveries were almost all in the coastal areas in the south-east and east of the Island. Of the 75 finds reported between May 29 and June 2, 69 were in the eastern half of Jersey, and of the nine areas in each of which 15 or more adults were found all except one were near the east coast, the exception being a find of 25 young beetles

in the north-west in September. Of the 59 larval infestations, 46 were in the east, mainly near the coast.

The above data, together with the fact that many thousands of dead beetles were washed ashore, indicate that the swarm from overseas was a very large one, that most of the beetles perished in the sea, and that the relatively few survivors which invaded Jersey only just managed to reach the eastern and south-eastern coastal areas. Further, since throughout the year the finds in the west were comparatively few, most of the invaders had probably been collected or destroyed by spraying soon after their arrival and before they had had an opportunity to spread to the west.

Incidence of Pest on Plants other than Crop Potatoes

(a) VOLUNTEER POTATOES In Jersey, after the early potatoes are lifted, almost all the fields are immediately sown or planted with other crops, among which numerous volunteer potato plants, originating from tubers left in the ground at harvesting time, appear in the autumn. Such plants also grow in the spring in the fields cropped with late potatoes the previous year. Obviously these plants are a menace, in that they provide excellent breeding places for the beetle because they are never sprayed and are apt to be overgrown and so overlooked. To lessen this risk, growers must, unless the circumstances are exceptional, plant potatoes in areas which were cropped with potatoes the preceding year. Grass or cereals, which are liable to overgrow and hide volunteer potato plants, cannot be sown without permission on land which has carried potatoes in the past year. Instead of grass or cereals farmers are encouraged to grow crops which can be kept free from volunteer potatoes. It is an offence to permit the growth of such plants, and growers are constantly urged to destroy them at once after ensuring that they are free from the beetle. Whenever possible areas suspected of carrying volunteer plants are inspected by the Department.

During the year beetles and/or larvae were found on volunteer plants in twenty-three places among tomatoes, turnips, mangolds, carrots, parsnips, mustard, grass, and on a rubbish dump. In such cases the volunteers are retained as trap plants where possible.

(b) OUTDOOR TOMATOES In two instances eggs and larvae were present on volunteer potatoes among the tomato crop; single beetles were found on tomato leaves in two cases and on the soil in tomato fields in eight cases. No eggs, larvae, or signs of feeding have ever been observed on tomatoes in Jersey. Apparently the Island tomato crop, which is thoroughly sprayed against Blight (*P. infestans*), is not preferred by the beetle.

(c) SOLANUM NIGRUM Three single beetles were found on this weed but no feeding had occurred. In six instances a few larvae, some almost fully grown, were discovered, and in four of them feeding had taken place. In view of the fact that the fertile invading beetles laid eggs in boxes, bottles, and other containers in which they were submitted for identification, it is perhaps not surprising that they should lay eggs on weeds of the potato family.

Spraying As in 1946, the difficult task of spraying the whole of the Island's potato crop was carried out satisfactorily by Plant Protection Ltd., under the direction of Major L. F. Braga. Before spraying began a survey was made and each potato area was plotted, numbered, and coloured to denote the kind of machine, knapsack or horse-drawn, to be used. Approximately 5,500 acres of earlies were planted on 5,335 plots on 1,943 farms; late crops covered 500 acres. It was planned to employ

27 horse-drawn machines, 106 knapsacks, and a labour force of 175 men recruited from the Polish Resettlement Corps, but these numbers were increased for a time immediately after the invasion in order to cover the crops as quickly as possible. Since the men would be working continuously among the potatoes, it was foreseen that they might be useful in discovering outbreaks. They were thus taught to identify the pest, with the result that no less than 79 cases were reported.

The crops were sprayed with a mixture of lead arsenate and Perenox, the latter being used at half strength (1 lb. in 40 gal.) for the first application in order to reduce the risk of scorching the tender foliage. Spraying started on May 5. The first application (5,500 acres) was completed on June 6, the second (4,576 acres) on June 20, the third (2,364 acres) on July 16, the fourth (1,052 acres) on July 25, by which date the earlies had been harvested or the haulms were dead. Late crops were sprayed with knapsack machines at approximately three-week intervals until early in October. In addition to the above, growers sometimes sprayed their own early crops so as to comply with the Order that "crops for export must be lifted within the four days following spraying".

Treatment of Infested Areas This was carried out by fourteen specially trained men, most of whom have now three or four years' valuable experience. It was based on the usual lines such as hand picking of the pest, spraying, soil injection, use of trap plants, etc., but was modified considerably in particular cases according to the nature of the infestation. This explains why growers and members of the public should report outbreaks but should not take any further action until the area has been inspected by the authorities. In Jersey frequent hand picking of adults and larvae is considered to have played an important part in controlling the pest.

Single beetle finds were followed by inspection, but no other special precaution was taken. In most cases no further finds were made.

Where many adults or larvae were found scattered in a crop, inspection and collection by hand were carried out at short intervals and the crop was re-sprayed as soon as it was considered safe to do so. At lifting time rows of potatoes here and there were left as traps, until the "lates," planted when the earlies were being lifted, had developed sufficiently to attract any remaining beetles. The same procedure was adopted when the outbreak was localized in a crop, except that the traps were confined to the infested area and a preliminary soil injection with carbon disulphide was given at once. Often finds were made by the Poles whilst spraying was in progress, in which case the work ceased immediately and was re-started only after frequent inspections had showed the site to be clear.

At one period it was observed that the adults were feeding only slightly or not at all, which meant that the lead arsenate spray, a stomach insecticide, could not be relied upon to kill them. Here the crop, after inspection, was treated with 5 per cent DDT dust, since laboratory tests had shown this material, acting as a contact insecticide, was toxic to adult beetles. For all these emergency sprayings of infested areas a special mobile team was kept in readiness by Plant Protection.

Besides the above treatment it is intended to carry out soil injection this winter, special attention being given to all outbreaks discovered late in the season, and where large larvae or young adults have occurred.

Inspection and Lifting of Crops All potatoes were grown under licence, and one condition was that growers must inspect their crops fortnightly from May 1 to October 31. It

is of interest to record that 78 finds were reported by growers and their men. In addition, all crops were inspected by Department Inspectors within the four days preceding lifting or before the haulms were destroyed by cutting or sulphuric acid. On completing the examination, the Inspector handed to the grower a permit to lift, and no consignment was accepted for export to the United Kingdom unless accompanied by a permit. For this work one Supervisor and thirty-nine men were employed, but at the peak of the season they were assisted by forty-two volunteers. Besides these official inspections, the possibility of outbreaks remaining undetected was further reduced by the method of lifting and grading; most of this was carried out by hand by Bretons from France, who are familiar with the appearance of the pest.

Harvesting had just begun at the end of May when the invasion occurred. Lifting was therefore prohibited immediately and was not resumed until June 9, by which time the situation was under control and only a few single beetles were being found daily. Produce from infested fields was not lifted until it was reasonably certain that most, if not all, the beetles or larvae had been collected or destroyed; this produce was not exported.

It will be seen from the above, together with the measures outlined in this report, that every practicable precaution was taken to ensure that the potatoes shipped to the United Kingdom in 1947 were free from infestation. Fortunately, potato growing was restricted to areas of two-ninths acre or over, which virtually eliminated garden crops; if this restriction had not been in force the possibility of controlling the pest would have been considerably reduced, because of the almost insuperable difficulties involved in spraying and inspecting innumerable small areas in gardens and elsewhere.

Prospects for 1948 In dealing with a pest such as the Colorado beetle it is perhaps unwise to attempt to predict the future, but the following observations may be of interest. Comparison of the Island infestations in 1945 and 1947 shows that the outbreaks were far more serious in the former year. For instance, the number of adults found in August and September, a critical period as far as hibernation is concerned, was 242 in 1945 but only 66 in 1947. Further, in 1945, after five years of German occupation, there was no existing organization to cope with the problem, materials and machines were scarce, large, weedy areas existed carrying neglected potato crops and numerous volunteer potato plants; all this has been changed in the past two seasons. Despite the heavy infestations and the difficulties in 1945, only 36 adults were found in 1946.

It would seem, therefore, that the position in 1948 should, at least, be no worse than it was in 1946, provided the stringent precautions are continued and no further heavy incursion takes place. If the 1947 invasion had occurred much later in the season, the outlook for 1948 would have been more serious, because many of the invading beetles would probably have hibernated before they could be destroyed. As for the 1947 invasion, this is the first of its kind to happen in Jersey, although the beetle has been prevalent on the neighbouring French coast for eight or more years. And with the possible exception of a few adults, no further incursion has occurred in 1947, despite the prolonged fine, warm summer, and the exceptionally extensive migrations recorded on the Continent. In addition, the incidence of the outbreaks, together with the fact that so many thousands of dead beetles were washed ashore, suggests that of the very large swarm which came from the Continent relatively few live beetles arrived in Jersey; and apparently even these only just managed to reach the eastern coastal areas. Indeed it is possible that few, if any, flew across the sea and landed directly on the island. It was thought that the invasion may have resulted from a dangerous increase in the beetle population on the neighbouring coast

of France during the past ten years, but a survey of this area does not support this view.

The weather of 1947 was exceptional, and there is no reason to expect that Jersey will frequently be subjected to heavy invasions from the Continent in the near future.

TRIALS OF POTATOES FOR IMMUNITY FROM WART DISEASE

THE official trials of new varieties of potatoes for immunity from Wart Disease conducted by the Ministry of Agriculture and Fisheries in collaboration with the Department of Agriculture for Scotland and the Ministry of Agriculture for Northern Ireland were continued in 1946 and 1947, and six new varieties, the descriptions of which are given below, have been added to the list of approved immune varieties.

A short list of the more commonly grown varieties which are approved as immune from Wart Disease may be obtained on application to the Ministry at Government Buildings, Block C, Lytham St. Annes, Lancashire.

EARLY

Ulster Prince

Sprout.—Blue.

Tuber.—Kidney ; skin white ; flesh white ; eyes shallow.

Haulm and Foliage.—Medium height, bushy, spreading later; dark green ; close drooping leaf, top growth flat, terminal leaflet to perpendicular ; long oblong leaflets, slightly wrinkled, waxy, terminal leaflet slightly overlapped ; secondaries medium size, few ; wings straight ; stems green but faint pink at base.

Flower.—Large white, numerous ; orange anthers.

SECOND EARLY

Ulster Emblem

Sprout.—Pink.

Tuber.—Oval or thick kidney ; skin white ; flesh white ; eyes shallow.

Haulm and Foliage.—Moderately bushy plants of medium height, spreading ; markedly grey-green ; long leaf and veins well marked ; leaflets long, flat and dull, leaflet margins tend to curl under ; few small secondaries ; wings crinkled ; stems green but distinct pink colour in mid-ribs of leaflets at growing point.

Flower.—White, profuse ; orange anthers ; deep red buds ; strong thick stalks.

EARLY MAINCROP

Red Fife

Sprout.—Pink.

Tuber.—Oval ; skin white ; flesh cream ; eyes red and shallow (colour confined to eyes).

Haulm and Foliage.—Tall, strong, open, upright ; leaf arched ; top growth standing well above plant ; small to medium leaflets, dull, hard and wrinkled ; medium to small secondary leaflets, not numerous.

Flower.—Deep red-purple, no white tips, numerous ; dark buds ; slender stalks.

Ulster Leader

Sprout.—Faint pink.

Tuber.—Thick kidney ; skin white ; flesh very white ; eyes shallow.

Haulm and Foliage.—Upright bushy plants of medium height, moderately strong ; dark grey-green ; leaf close and arched ; leaflets large, broad, dull, slightly fluted and cupped ; numerous large secondary leaflets ; wings very crinkled and broad ; stems thick and green.

Flower.—Numerous white ; buds light green.

TRIALS OF POTATOES FOR IMMUNITY FROM WART DISEASE

LATE MAINCROP

Craigs Bounty

Sprout.—Pink.

Tuber.—Kidney inclined to be flat; skin white and netted; flesh white; eyes shallow.

Haulm and Foliage.—Very strong plants of medium height, bushy providing good cover, compact; yellowish-green colour; very long drooping leaf; large thick leaflets, wrinkled and harsh, dull; secondary leaflets few; wings thin and straight; stems green.

Flower.—Small red-purple, tipped white, numerous; anthers orange; buds coloured at base; stalks slender.

Ulster Supreme

Sprout.—Faint pink.

Tuber.—Flattish oval; skin white; flesh white; eyes shallow to medium.

Haulm and Foliage.—Strong, upright, medium height, even growth; dark green; close short leaf; leaflets broad and wrinkled; round terminal overlapped; secondary leaflets fairly small, not numerous; wings slightly crinkled; stems thick and green with pink tinge developing towards maturity.

Flower.—Light blue-purple tipped white, not frequent; anthers yellow and loose; short flower stalk coming from growing point; buds pink and hairy, dropping readily.

COMMONWEALTH AGRICULTURAL BUREAUX

As from January 1, 1948, the Imperial Agricultural Bureaux changed their name to the "Commonwealth Agricultural Bureaux". This change has been made because the Executive Council felt that the use of the word "Commonwealth" rather than "Imperial" is more in keeping with modern trends.

The Imperial Agricultural Bureaux were founded in 1929 by agreement among the Governments of the British Commonwealth and Empire. Each cooperating Government appoints its own representative on the Executive Council, which is responsible to all the cooperating Governments jointly. The organization is financed by the cooperating Governments in agreed proportions, and its work is reviewed by successive Commonwealth Conferences.

The main function of the organization is to act as an effective clearing-house for the interchange of information of value to research workers in agricultural science and forestry throughout the various parts of the Commonwealth and Empire.

The organization which the Executive Council controls consists of the Institute of Entomology, the Mycological Institute, the Bureaux of Soil Science, Animal Health, Animal Nutrition, Plant Breeding and Genetics, Pastures and Field Crops, Horticulture and Plantation Crops, Animal Breeding and Genetics, Agricultural Parasitology (Helminthology), Forestry, Dairy Science, Biological Control and the South American Potato Collection.

Journals The following list comprises journals and other periodical publications issued by the Bureaux. Subscription rates are quoted after each; in certain cases (journal marked with an asterisk) a 20 per cent deduction is made for subscribers in the British Commonwealth who send their subscriptions direct to the Bureaux offices.

Owing to higher costs of production, the subscription rates for most of the journals of the Commonwealth Agricultural Bureaux have had to be increased. The rates quoted are current for all journals except

COMMONWEALTH AGRICULTURAL BUREAUX

Helminthological Abstracts, Dairy Science Abstracts, Forestry Abstracts and *Forest Products and Utilization.* The new rates for *Helminthological Abstracts* and *Dairy Science Abstracts* come into force in May, 1948. The new rates for *Forestry Abstracts* and *Forest Products and Utilization* which will also come into force in May, 1948, have not yet been decided.

Bulletin of Entomological Research	40s.
Review of Applied Entomology (Series A)	40s.
Review of Applied Entomology (Series B)	20s.
Review of Applied Mycology ..	40s.
*Soils and Fertilizers	35s.
Veterinary Bulletin	40s.
Index Veterinarius	100s.
Nutrition Abstracts and Reviews	60s.
*Plant Breeding Abstracts ..	35s.
*Herbage Abstracts	35s.
*Horticultural Abstracts	35s.
*Animal Breeding Abstracts ..	35s.
Helminthological Abstracts ..	35s.
*Dairy Science Abstracts	35s.
*Forestry Abstracts	25s.
Forest Products and Utilization..	10s.

All correspondence concerning subscriptions and requests for specimen copies should be sent to: Commonwealth Agricultural Bureaux, Central Sales Branch, Penglais, Aberystwyth, Wales.

AGRICULTURAL INDEX NUMBER

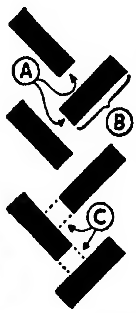
MONTHLY INDEX NUMBERS OF PRICES OF AGRICULTURAL PRODUCTS INCLUDING GOVERNMENT GRANTS. (BASE 1927–29 = 100)

Month	Uncorrected for Seasonal Variation					*Corrected for Seasonal Variation*				
	1939	1944	1945	1946	1947	*1939*	*1944*	*1945*	*1946*	*1947*
January ..	95	190	192	199†	218†	*89*	*171*	*173*	*179†*	*194†*
February ..	94	186	193	201†	211†	*88*	*172*	*176*	*182†*	*190†*
March ..	91	180	185	192†	202†	*91*	*176*	*178*	*183†*	*192†*
April ..	90	163	167	176†	186†	*95*	*170*	*173*	*182†*	*192†*
May ..	82	151	154	162†	172†	*91*	*170*	*173*	*181†*	*193†*
June ..	80	149	154	161†	170†	*89*	*169*	*174*	*181†*	*193†*
July ..	85	155	162†	168†	181†	*93*	*169*	*177†*	*182†*	*197†*
August ..	86	155	162†	177†	192†	*91*	*172*	*174†*	*191†*	*208†*
September	92	151	159†	177†	206†	*93*	*157*	*166†*	*188†*	*222†*
October ..	96	171	179†	193†	221†	*92*	*164*	*172†*	*187†*	*215†*
November	106	183	191†	209†	234†	*98*	*169*	*177†*	*193†*	*216†*
December	113	189	197†	214†	240†	*103*	*170*	*178†*	*192†*	*216†*

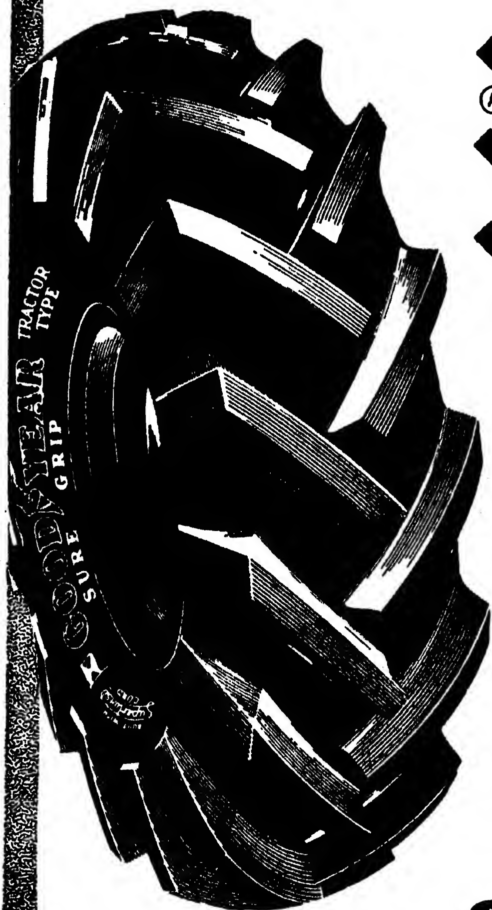
† Provisional.

2522 Wt. 16 3/48 CN&Co 466

Why it WORKS



The o-p-e-n c-e-n-t-r-e tread of the Goodyear Sure-Grip tractor tyre gives each tread bar a BITE EDGE (*a*) that permits the entire lug (*b*) to penetrate full depth and length, ensuring maximum grip and pull. Connecting bars (dotted lines *c*) would form mud pockets that fill up, causing slip and spin, and give no point of penetration to start traction bite. The Goodyear tread, which is o-p-e-n at the centre and has no connecting bars, is fully self-cleaning, always deep-biting.



GOODYEAR

SURE-GRIP TRACTOR TYRE

Please mention the JOURNAL *when corresponding with Advertisers*

May, 1948

Agriculture

The Journal of the
Ministry of Agriculture

No. 2

PUBLISHED 6d MONTHLY

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

Editorial Offices: 55 Whitehall, S.W. 1 (*Phone*: *WHItehall* 3400)

VOL. LV | No. 2 | MAY 1948

Contents

Cover Photograph

Potato Planting at Thirlspot, Cumberland .. *G. Bertelsman*

GRASS AND THE DAIRY COW

E. R. COCHRANE, M.A.
Fresden, Highworth, Wilts

FEW would question the statement that grass is the best and cheapest food for cattle. Even those few would hardly dispute that, given suitable cows, good grass provides the best and cheapest food which we, in a debtor country, with our much-qualified weather, are likely to be able to provide for them. But there are two aspects of the relationship between grass and the dairy cow. Not only must we have grass to suit the cow, but we must also have a cow to suit the grass.

Cows to Suit Grass Our pastures, whether good, bad or indifferent, are essentially man-made; they are the result of natural adaptation to conditions which we have imposed. In the same way our cattle are also mostly man-made, since we have substituted our selection for that of nature and have selected for characters which are far from natural.

It would seem reasonable, therefore, that our cows should be selected and bred for their efficiency in converting grass into human foodstuffs. A hundred and more years ago they were so selected by Thomas Bates and other improvers of cattle. I suggest, however, that during the last, say, fifty years, dairy cows have been selected increasingly for their response to the feeding of concentrates, or at least that dairy bulls and their dams have been thus selected by pedigree breeders. And since a herd consists, as to its inherited make-up, largely of the contributions of the last four sires used in it, the influence of bulls and bull-breeders cannot be exaggerated. The reasons for this selection are probably two: first, an increasing emphasis on winter milk production and the consequent importance of hand-feeding, and second, the effort to obtain high yields upon which the sale of dairy bulls so much depends. It is clear that the conversion of concentrates in large quantities calls for a rather different type of cow (if not of animal) than does the conversion of bulky foods such as grass; we are hardly fair on our cows if we expect them to spend half the year on grass and the other half on tabloids-cum-fibre. If in future we are to lay the emphasis on grass this must, of course, include good hay, silage and dried grass.

I would therefore suggest that some of us, at least, might reconsider this policy of scouring the earth for foods to tickle the palates of our cake-converter cows. Would it not be at least as sensible to select and breed for the efficient conversion of the food or foods which we can cheaply and conveniently provide—*to breed for our feeding rather than feed for our breeding?*

There are several qualities for which we might look if we are out to establish a strain of grass-converter cattle. First, they must have adequate digestive, and especially rumen, capacity to deal with considerable quantities of bulky foods.

Secondly, we must select quick grazers, as our forbears did. We have only to watch the grazing habits of any dairy herd to discover the vast difference between individuals in this respect. Some of my cows attain a rate of eighty bites per minute on good pasture, but I have one or two others which, when they settle down at all, eat at about half this rate—they spend so much time looking for the perfect plant that they almost starve themselves! We have also observed striking differences in the grazing efficiency of tethered bulls.

Thirdly, we might profitably select for non-scourers. All cows scour to some extent on a lush spring pasture, but there is considerable variation. Cows which scour badly are not only unmitigated nuisances but obviously

cannot utilize efficiently the food they have eaten. Tendencies of this kind seem to be highly hereditary and one extreme may be as detrimental to performance as the other. It was noticed some time ago by Cambridge workers that when a group of Hereford and Aberdeen Angus cattle were grazing the same pasture simultaneously, the Hereford made good gains while the Angus scoured. On closer observation it was seen that the Herefords forged straight ahead like so many lawn-mowers eating everything which came their way, while the Angus were much more selective.

Fourthly, I would suggest, as others have done on occasion, that the comparatively small cow may well be a more efficient utilizer of grass ; she is normally more agile and, whereas good grass can provide sufficient nutrients for a small cow's maintenance and 5 or so gallons of milk, no grass on earth can meet all the requirements of a big, 10-gallon cow. Where record-making (which is, of course, much influenced by size) is not the main object, there is something to be said for the smaller animal.

Finally, I think that the grazing cow should not be so ultra-specialized for milk production as to milk heavily at the expense of her body when the grass is not up to standard. That, of course, is a moot point, but even with the greatest care one can seldom, if ever, offer perfect herbage to one's herd throughout the grazing season, and supplementary feeding is not always convenient, or perhaps economical.

I submit these considerations regardless of breed labels. Today, the strain within the breed is more important. *But rearing for grass conversion is at least as important as breeding for grass conversion.*

Grass to Suit the Cow We have to remember that swards are established and maintained for the sake of livestock, and not vice versa. I suspect that some grassland experts are as loth to see their best swards spoilt by stock as is the prize ploughman to see his furrows torn out of recognition by further cultivations. Furthermore, dairy farmers who have self-contained herds (and sooner or later nearly all herds, being T.T, will be self-contained) cannot discard or add to their numbers according to the growth or lack thereof of grass. For the maintenance of a good sward, mixed grazing is ideal, but it is surprising how well one can get along with cattle only, while sheep can cause considerable damage by eating the heart out of the plant.

There are half-a-dozen characters which occur to me as being essential to our pastures :

(a) quick recovery after grazing,
(b) resistance to drought and poaching,
(c) suitable texture,
(d) long grazing season,
(e) persistent productivity,
(f) fertility build-up.

Recovery after Grazing According to Welsh experiments there is no doubt that ryegrass stands hard grazing better than any other grass. This is doubtless why most of our first-class old pastures are predominantly ryegrass swards. Perhaps Italian ryegrass is the best in this respect, although some strains of cereals are quite remarkable in their speed of recovery after grazing. Cocksfoot is also good, particularly after mowing for hay. All grasses, however need "close seasons" for recovery, and under conditions of low or moderate rainfall he is a clever farmer who can get much from a ryegrass sward in July and August. I do not know what work has been done on the speed of recovery of clovers ; my own experience is that they usually tend to smother out my grasses and can

therefore be too much of a good thing. That, however, may be the result of overstocking.

Resistance to Drought and Poaching The effects of too much or too little rain may, I think, be reduced by similar measures. First, by the use of deep-rooted plants such as cocksfoot, lucerne and some clovers, since neither lack nor excess of rain has so much effect on deep-rooted plants. And secondly, by adequate supplies of organic matter which act as an insulation and as a sponge, both absorbing and retaining moisture. Such organic matter, yard muck, straw or whatever it be, should be on or near the surface and not, I think, buried. It follows, therefore, that the shallow-rooted plants such as ryegrass are more dependent on organic matter and applied minerals than are cocksfoot and other deep-rooters. It is possible that top dressings with fertilizers, when applied in dry weather to shallow-rooted plants, further encourage the shallow-rooting habit and make these plants more vulnerable to drought. It is also probable that low seed rates, giving fewer but larger plants per square yard, provide a more drought-resistant sward than high seed rates.

Suitable Texture It is frequently recommended that grass should be grazed when it is about 4 inches high. I am rather doubtful as to the advisability of this for cattle. As Sir George Stapledon says, it is not the *extent* but the *rate* of growth that matters, and I know of no better grazing sward than a stand of Italian ryegrass 12 inches or more high at a time of year when it is not running to seed. Cattle do not scour on such a sward, and there is, in my opinion, far less waste of protein and other nutrients. Few grasses prove so persistent when kept more or less constantly grazed as when they have the chance to develop into half-grown plants; and, undoubtedly, the shorter grass is kept the shallower the rooting system tends to become. Leafiness, however, is all-important, and whereas we know that some strains are leafier than others, I doubt if sufficient attention is paid to the fact that under certain soil conditions a leafy strain of grass may produce an abundance of fibre, while under the opposite conditions a stemmy strain will produce an abundance of leaf.

Long Grazing Season Here again ryegrass, cocksfoot and cereals seem to score by their early and late growth. Moreover, organic matter helps in increasing the soil temperature in spite of cold winds and excessive rain. I am sure we can do much to increase the length of the grazing season—personally I am disappointed if I cannot start serious grazing in March or if I have to begin winter feeding before November, and I am farming in a district of low summer rainfall. We have, however, to consider the needs of the plant itself, and for this reason, if for no other, I think that it may pay to rely on the grazing of cereals for the first spring and last autumn feeds. Cereals as a whole are far less greedy than grass and clovers in their demands on soil fertility, and it is amazing how much keep one can get from rye under conditions of high fertility and how much it is relished by cattle.

Rape, hardy green turnips and other such crops can be extremely useful at the end of the year as well as the beginning, and there are many possibilities, which personally I am only beginning to explore, with regard to foggage. It is conceivable that all swards should be "fogged" occasionally to help their root development.

Persistent Productivity It is heart-rending to establish what we think is a first-class ley, to have difficulty in keeping it grazed down during the first harvest year, and to discover in

the second that there is little or no vigour left in the sward. Many have damned ley farming as a result of such experience. Much of the trouble is, I think, due to the use of Italian ryegrass as a nurse crop on fertile soil. Given conditions it likes, it is so aggressive that it can be relied on to smother practically anything else we sow with it during its first season. When it has died off towards the end of that season or the next there is little or nothing left of the other sown grasses. At Fresden, I conclude that Italian ryegrass should be sown by itself with one clover for company.

If we want a persistently productive sward we must pay particular attention to cultivations and manuring before establishment. The usual method of turning over turf, whether old or new, and then consolidating like mad with every known implement, works quite well on light soils which cannot be de-aerated and especially when the ploughing is shallow. But this is, in fact, I suggest, the reverse of cultivation, and the ploughing under of organic matter, together with the consolidation required to prevent a hollow seedbed, may have the effect of reducing fertility on heavier land. At all events I can grow oats quite satisfactorily when I do this sort of thing, but I have the greatest possible difficulty in preventing lodging, no matter what variety I try, if I grow oats on land which I have *really* cultivated. Faulkner was, I believe, right in referring to a layer of ploughed-in organic matter acting as blotting paper, absorbing moisture from above and below and drawing it away from the young seedling. Possibly the best crop to grow before seeding to grass would be potatoes, the cultivations for which appear to release an amazing amount of nitrogen and other plant nutrients.

If we try to keep our swards unfouled, we must restore their fertility in some form or another. If we do not work muck into the seedbed for our ley we might profitably, I think, apply it during the first or second winter, as is often done in the North. But whatever treatment we adopt we must choose species of grasses and clovers which suit our soil; otherwise they will not and cannot persist. Covered-yard muck, containing not only straw but liquid manure, is possibly best for the top dressing of grassland. But it must, I find, be applied after rotting.

FERTILITY BUILD-UP Grasses and clovers are, as I have said, among the greediest plants we grow. It is, therefore, important that the fertility of a grassland farm should be steadily increased and not depleted. Here I would merely emphasize the need for persistent productivity and draw attention again to the advantages of deep-rooted plants in increasing the organic matter content, and in due course the humus content, of the soil. It may be that in all swards, even predominantly ryegrass swards, we should attempt to maintain a certain amount of cocksfoot for this reason alone. But, so far as I know, no experimental work has been done to find out the effects on subsequent cropping (of grass or anything else) of a ryegrass, as compared with a cocksfoot, timothy or fescue sward under differing soil conditions. This would seem to be a fruitful field for investigation.

Utilization of Pastures There are many arguments as to the best means of utilizing grazing swards in order to give the best chance to the animal and the sward and yet avoid waste. Some allow their cows to graze three times a day on a good sward, turning them between-whiles into a rest paddock which is usually permanent grass or a long ley. In this way the cows get the benefit of the shorter leys, together with what useful herbage and weeds there may be on the older swards. I would indeed suggest that until we know more of the full requirements of cattle a herd should have access to at least two different types of sward

every day. Roughage and succulent feed are both required, and are indeed complementary ([1]). It would seem that roughage is preferred for breakfast and supper, and succulence at midday([2]).

Evidence regarding grazing habits is still far too scanty, but Johnstone-Wallace, working in New York State, found that a beef herd, given unrestricted grazing, carried out 60 per cent of their grazing during the day and 40 per cent during the night([3]). Confirming this, I have frequently observed my cows grazing hard at or about midnight. On the other hand, Seath and Miller, working in Louisiana, found that in very hot weather—85° to 86° F.—only about 20 per cent of grazing took place between 7.15 a.m. and 2.35 p.m. when the cows were brought in for milking([4]). This is confirmed by the experience of those who have erected shelters for the benefit of cattle during the winter, only to find them used much more consistently during the summer for shade.

It would indeed seem that the rumen acts not only as a fermentation vat but also much like a camel's hump, allowing the cow considerable latitude as to when she will feed.

Much has been said about the advantages of grazing cattle in relation to the manuring of pastures. Where intensive grazing is the rule I have considerable doubts about this. Leys in particular respond rapidly to stock nitrogen, and it is only too easy to get a sward into what one might call a condition of spotted fever. Top, harrow or graze as we will, these spots can continue throughout the grazing season to produce rank growth which cattle will not eat. Some harrows are more efficient than others in dealing with droppings, although I have met none which do the job to my satisfaction. But no harrows on earth can spread liquid excreta, the effect of which seems to persist for months. Mixed grazing undoubtedly helps, but I do not consider it a complete solution for this trouble.

Again, where rest paddocks are concerned—and one must remember that cows excrete more at night than during the day—the same problem arises in an exaggerated form. We all know of corners in our fields which, presumably because of shelter, are selected as dormitories. Such areas grow an abundance of grass which is seldom if ever eaten by cattle. Moreover, although I am a firm believer in the value of muck, I do not care for it in its raw undiluted form even as a plant food. It may well be that the more muck, the greater the need for frequent liming, irrespective of *p*H at plough depth.

When cattle are grazed for short periods on good swards there is little or no soiling, and I have repeatedly proved that cows alone can graze a sward in such a way that it is almost impossible to believe that a mower has not been used. The smaller the area the easier it is to control grazing, and here the electric fence is invaluable, except for those animals which seem to be exhilarated rather than deterred by electric shocks! But I find barbed wire essential for my phlegmatic cattle.

Intensive rotational grazing, however, has three serious disadvantages. First, the necessity for labour, which need not, however, be skilled; second, the necessity for paying back the swards so grazed in return for the fertility removed from them; and third, the need for variety of herbage and for shelter.

A Fundamental Problem Even if we have solved these many problems, the fact—the tremendously important fact—remains that cattle do much better in some fields than in others! And they have strongly expressed preferences, the reasons for which,

unfortunately, they cannot explain. Have we tried hard enough to find out the reasons for these preferences? What sort of balanced sward do they need? The ratio of proteins to carbohydrates, the balance between amino-acids, the amount and type of fibre, the combinations of various grasses and clovers, the balance between different minerals and trace elements—all these considerations may affect the final result. And it must, I think, be admitted that we know little about them. We do not even know whether milking cattle need the same balance of nutrients at different seasons, for we have seriously upset the seasonal lactation rhythm and expect a milk-stimulating diet at a time when a normal cow should be drying off. The effect of this procedure on fertility and longevity is not easy to assess; suffice it to remember that 175 years ago Arthur Young wrote of cows normally "lasting good until 14 or 16 years old". The average life of English cows today is just about half that period, and it is doubtful if all of them "last good" even that length of time.

This question, why some pastures are much better than others, seems to me even more important and urgent than that of deciding as between temporary and permanent grass. There is little point in obtaining greater productivity if it is not the kind of productivity which dairy cattle need. Do we not sometimes choose our seed mixtures for convenience in sward management, or for their suitability as crops to our particular soils, rather than for their advantages for, or popularity with, our cattle? Do we not assume that we know what our herd ought to want in the way of pasture? And how often are we correct in our assumptions?

Unfortunately, it has so far proved impossible exactly, or even approximately, to measure the productivity of a sward in terms of milk output. Valuable work has been done with the meat animals, but the dairy cow, influenced as she is by such a multiplicity of factors, has proved to be most intractable experimental material. In my view identical twins should be used.

The scientist is, rightly enough, suspicious of that which he cannot measure or weigh, and there is nothing more irritating to him than to be told vaguely that A is better than B without adequate objective evidence. Yet, for the time being, we have little else to work on; and just as we know of pastures which regularly fatten one or more beasts to the acre, so there are well-known milking swards which would surely repay close study to find out their common characteristics. Some pastures are good for milk, some for beef and others for rearing; some indeed are dual-purpose, but others seem to be definitely single-purpose.

There are various possible explanations for the superiority of one sward over another. First, the herbage may differ. I must confess, however, that it has not been my experience that the best herbage in theory has always provided the best in practice. And I have certainly sown different fields with identical seed mixtures with entirely different results. Carruthers investigated swards from 63 of the best fattening pastures in England, and analysed his results in a paper published by the R.A.S.E. in 1890([8]). The outstanding pasture was that of Pawlett Hams in Somerset, yet the predominant grass, meadow barley grass (*Hordeum pratense*), was rated by him (and as far as I know by all other agronomists) as a weed. The pasture also contained ryegrass and clover, but its botanical composition was by normal standards inferior to nearly every other pasture he examined. (A recent analysis showed that *Agrostis* and ryegrass are now dominant.) Considering this he asked himself what that land would have carried had the herbage consisted of superior species—possibly it would have been even better than it was; but we do not know. Some of the virtue of the Hams is, however, probably due to periodical flooding.

The fact that we have sown a given seeds mixture consisting of a suitable balance between different species and strains by no means ensures that a similarly balanced sward will result. I have sown the same mixture on the same day in the same field, only to get on one plot a ryegrass-dominant sward and on the other a cocksfoot-dominant sward, presumably owing to differences in previous cropping, manuring and cultivations. And as I have mentioned, Italian ryegrass (and S100) can smother out other ingredients of a seeds mixture.

Carruthers came to the conclusion that "the feeding value of pasture depends more on the quality of the soil than on the nature of the herbage of which it is composed". I agree, but I wish we could discover what are those virtues inherent in some soils and absent from apparently similar land. Soil analyses, again in my experience, do not help. As normally undertaken they ignore the subsoil and they tell us nothing about the intensive micro-biological activity which, if I am not much mistaken, takes place more particularly in the top half inch of top soil. It seems likely that the manner in which a field has been cropped, cultivated and manured over a period of years has much to do with the results we get when we seed it down to grass, but this can hardly explain the superiority found among certain pastures which have been established for a hundred years or more.

Some attribute rare virtues to weeds, which thereupon acquire the more dignified name of herbs. It is likely that animals benefit from certain mineral-efficient plants such as ribgrass, yarrow, chicory and certain weeds ; there may indeed be something to say for my pet abomination, the dandelion. It is probable that some plants have a function to play in supplying trace elements, one or more of which may be a limiting factor for health or production, possibly through the endocrine system. The somewhat disastrous effects of the oestrogen, or oestrogen precursor, seemingly present in certain subterranean clover pastures in Western Australia, may provide us with an important clue(6).

The *application* of fertilizers can, I think, at best supply a partial answer to our problem. But the *availability* of certain minerals (perhaps especially lime and phosphates) may give us a clue to the essential differences between a milking and a fatting pasture. And availability seems to be a function of micro-biological activity and of adequate root development at least as much as of fertilizers. Furthermore, the use of fertilizers for any soil or crop assumes that we know what deficiencies there are in a soil and the amount and availability of the element required to make those deficiencies good. But do we ? And if so, how often ?—always excepting such gross deficiencies as are more or less susceptible to chemical analysis. Dr. Wallace's work in analysing soils by means of certain plants grown on them is indeed a promising approach to this problem, but it is as yet in its infancy.

Be that as it may, we are all of us conscious of deficiencies but not, I think, equally conscious of excesses, which are often the reverse of the same coin. The teart pastures of Somerset cause scouring through excess of that unpronounceable element molybdenum, but the condition is best treated by supplying copper to the animal, since it is the ratio between the two elements, rather than their absolute amounts, which matters(7). Excessive liming can cause boron deficiency or the locking-up of magnesium. Excessive nitrogen may induce the plant to use up its reserves of phosphates and potash, so that the last stages of a pasture may be worse than the first, if care is not taken. We are all so anxious to obtain heavy crop yields that we sometimes apply more fertilizers than the plant requires ; and when we do get a good crop we too seldom know whether it is because of, or in spite

of our generosity. Fortunately, most plants are amazingly tolerant ; sometimes they have to be.

These problems are further complicated by the fact that we do not yet know to what extent we can trust the judgment of cattle. Rats, chicks and other animals have shown their ability to select for themselves a superior (and on occasion even more economical) diet to any devised by man. But the few experiments carried out with dairy cattle suggest that the cow's great idea is to make a pig of herself ! This may be the result of years of frustration—if ample supplies of pre-war food were available to us all today many of us would fail to utilize it in the form of extra hard work tomorrow ; it is even possible that we might work less well because of our repletion—or indigestion. I think there is immense scope for further self-selection feeding experiments, and that if possible they should be conducted with nurse cows which have been allowed to select their own rations since calfhood. One line of action might be to use such individuals as show exceptional "nutritional wisdom" to teach us how to feed the rest, as Dove has done successfully with chicks.

At the moment we are all hindered by the inability to distinguish "need from greed" in Dove's phrase. Consequently, many high-yielding herds are fed lavishly, regardless of cost, in the hope that they will get all they need. Very often they do—but the question is, how much extra do they get beyond their needs ? And in what way can we substitute cheap foods for dear, foods we can produce for foods we cannot produce, without losing efficiency ? On some pastures cattle remain content even when we cannot see on what, if anything, they are living and milking. On others, they are discontented, no matter how much keep there may be. I wish I knew why. Of one thing only am I certain : that it need not, does not and must not take 4 lb. of concentrates (averaging winter and summer feeding) to produce a gallon of milk. That figure was the pre-war consumption of the 600 herds costed for milk production by the Agricultural Economic Research Institute for the Milk Marketing Board.

Conclusion In conclusion, therefore, I would suggest that we have far more knowledge of the technique of establishing swards than of the habits and needs of the cattle intended to utilize them ; that we know more about the bred strains of grasses and clovers than about the effects of soils and cultivations. We know far more about disease than about the animal's requirements for health. Most of us in this, as in many other farming matters, are so greatly preoccupied with methods that we have little time left to discover to what extent these fulfil our ultimate aims.

In any cropping or feeding problem we are up against an intriguing number of variables ; climate, soils, fertility, strains, management, and the endless complications of the animal organism. It is extremely hard for us to disentangle cause from effect, heredity from environment. A further difficulty lies in the fact that as farmers we are concerned with *wholes*, the soil as it is, the sward as we can make it, and the animal in its individuality. But scientists are normally concerned with *parts* and, at least where living organisms are concerned, the whole is greater than the sum of its parts. Any major farming problem is essentially an ecological problem and therefore requires attack in the form of a combined operation by botanists, chemists, soil scientists, agricultural engineers, animal physiologists, geneticists, economists, veterinary surgeons and farmers. If only teams such as these would set to work to find out wherein lie the virtues of first-class pastures for milk production under different soil conditions, we should,

I feel sure, make rapid progress towards the better and more economical feeding of our dairy herds.

References

1. GREGOR, J. W. The Complementary Principle in Grassland Farming. *Agriculture* (1947) **54**, 9.
2. STAPLEDON, SIR R. G. The Palatability and Nutritive Value of Herbage Plants. *Agriculture* (1947) **53**, 428.
3. JOHNSTONE WALLACE, D. B. and KENNEDY, K. Grazing Management Practices and their Relationship to the Behaviour and Grazing Habits of Cattle. *J. Agric. Sci.* (1944) **34**, 190.
4. SEATH, D. M. and MILLER, G. D. Effect of Warm Weather on Grazing Performance of Milking Cows. *J. Dairy Sci.* (1946) **29**, 199.
5. CARRUTHERS, W. The Composition of some of the Famous Ancient Pastures of England. *J. Roy. Agric. Soc. Eng.* Third Series (1890) **1**, 751.
6. BENNETTS, H. W. *et al.* A Specific Breeding Problem of Sheep on Subterranean Clover Pastures in Western Australia. (Abstract) *Herb. Abstr.* (1946) **16**, 285 (1669); (1947) **17**, 211 (1147 and 1148).
7. FERGUSON, W. S. The Teart Pastures of Somerset. IV. The Effect of Continuous Administration of Copper Sulphate to Dairy Cows. *J. Agric. Sci.* (1943), **33**, 116.

COLORADO BEETLE IN ENGLAND, 1947

C. T. GIMINGHAM, O.B.E., B.Sc. and I. THOMAS, M.Sc., Ph.D.
Ministry of Agriculture and Fisheries

THE continued spread of Colorado beetle throughout north-western Europe and the discovery of 12 colonies on potatoes and 13 single beetles at different places in England in 1946*, made it clear that the threat to this country was increasing and an invasion in 1947 on a larger scale than hitherto could be expected. The occurrence of two small colonies in our eastern counties potato-growing area in 1946 was alarming and, although every possible precaution had been taken to see that not a single beetle survived, it was evident that 1947 was likely to prove a difficult year.

The results of the thorough measures of control adopted in the past have been successful, since in no single instance where Colorado beetle has been discovered has it reappeared in the same place the following year. Little or no anxiety was therefore felt with regard to the complete eradication of the centres of infestation in 1946, but inevitably there was some uncertainty whether every single colony, however small, had been detected in 1946 and whether, in spite of every precaution, a few beetles might not have found their way here from the Continent in the late summer and survived the winter without being discovered. Evidence of the appearance of the beetle in numbers on piers and quays at certain ports across the Channel had been obtained in 1945 and 1946, and with the increase of cross-Channel traffic since the war years, the insects may more easily be transported to our shores.

* See *Agriculture* (June, 1947), **54**, 121.

Organization and Methods Before describing the occurrences in 1947, it will be convenient to sketch briefly the organization and methods adopted by the Ministry to deal with the Colorado beetle problem in this country.

The Colorado Beetle Order of 1933, made under the Destructive Insects and Pests Acts, makes it illegal to retain possession of a live Colorado beetle or to spray or otherwise treat any crop infested by, or suspected to be infested by, this insect. Other provisions are designed to ensure that any occurrence of the pest in this country shall be dealt with only by qualified officers acting for the Ministry of Agriculture. Under the Importation of Plants Order of 1947, restrictions are placed on the importation of potatoes and other agricultural produce from certain countries, with the object of reducing the risk of introducing Colorado beetle and other plant pests and diseases.

The field work aims at the complete eradication of all beetles or breeding colonies of the insect that are discovered so as to prevent the pest establishing itself in Great Britain. The measures taken are therefore more drastic than would be necessary if the aim were simply to control the pest. The Ministry directly, or through its agents, carries out all field operations; farmers, growers and the general public are asked only to look out for the pest and to notify the Ministry or the police immediately a Colorado beetle or its grubs, or any insects suspected to be Colorado beetles, are found. Propaganda to familiarize the public with the appearance of the pest by means of leaflets, posters, press articles and broadcasts is therefore an important part of the organization. That the active cooperation of the public has been obtained by this propaganda is shown by the many thousands of specimens suspected to be Colorado beetles received each summer by the Ministry's Plant Pathology Laboratory and the provincial centres of the National Agricultural Advisory Service.

The administrative work in connection with the Colorado beetle campaign is dealt with by the Horticulture Division of the Ministry, and the headquarters of the technical work is the Ministry's Plant Pathology Laboratory at Milton Road, Harpenden, Herts. Operations on the site of any occurrence of Colorado beetle are the responsibility of the Advisory Entomologist (N.A.A.S.) in the province concerned, acting in cooperation with the Laboratory. Field-scale spraying and dusting of potato crops is carried out for the Ministry by Plant Protection Ltd., who have built up an extensive organization for this purpose.

Arrangements for field spraying and dusting are made under two headings:

(a) "Emergency" Treatment, that is, the treatment of the crop in a field where Colorado beetle has been found (after the actual infested area has been dealt with) and of potato crops in nearby fields, usually within a radius of ½ to 1 mile of the infested field. This work has first priority, and men and machines are available to go anywhere at very short notice.

(b) "Protective" Treatment, that is, the treatment of potato crops in certain areas, purely as a precautionary measure. This includes all fields in the neighbourhood of any sites of breeding colonies dealt with in the preceding year, and also potato crops around certain ports and in areas, such as the Thames estuary, that are considered to be specially vulnerable to attack. In the past two years this has involved spraying or dusting some thousands of acres of potatoes. Every field treated is inspected by an

officer of the N.A.A.S.* and the work has to be certified as having been performed efficiently.

It will be realized that to carry out these treatments on a large scale, the potato fields in the areas designated have to be located and mapped, and all arrangements made well in advance to ensure that sufficient trained spraying personnel, machinery, insecticides and ancillary material are available in good time.

In the past few years the chief insecticide used for spraying has been lead arsenate, but since the value of DDT for the control of Colorado beetle has been proved by experience on the Continent and in North America, insecticides containing DDT, both sprays and dusts, are being used increasingly. For field work, air-blast (Agro) spraying machines and tractor-mounted dusting machines are used (see p. ii of art inset) ; for small areas and corners of large fields, knapsack sprayers or rotary hand-dusters are brought into use.

In addition to the application of insecticides, potato crops in vulnerable areas are searched for beetles or grubs. Careful searching is also undertaken in any field in which a colony of the pest may be reported and in neighbouring crops of potatoes. Most of this work is carried out by teams of temporary inspectors, mainly University students of biology, recruited specially for the purpose. These inspectors may also help with work on the site of an occurrence.

If a Colorado beetle or a colony of beetles or grubs is reported in a field or garden and the identity of the insects confirmed, the site should be carefully marked but otherwise left completely undisturbed until the arrival of an entomologist. He will first ascertain the extent of the infestation and, under his supervision, the plants will be examined one by one and all beetles, grubs and egg-masses collected by hand. The potatoes on the infested plot, which up to the present has been commonly an area of about 10 yd. square, are then lifted (see pp. ii and iii of art inset) and the haulm, after further examination, treated with an insecticide to ensure destruction of any small grubs that might have been missed, and then buried. The surface of the plot and several rows of potatoes around it are liberally dusted with DDT, and carbon disulphide is then injected into the soil by means of hand soil injectors (see p. iii of art inset) in order to kill any fully fed grubs, pupae or beetles that may be below ground. The remainder of the field and the potatoes in nearby fields or gardens are searched, and then sprayed as soon as possible thereafter. The sites of all occurrences of breeding colonies are kept under close observation throughout the season.

In certain circumstances—for example, if beetles are found late in the season when potatoes are being lifted—it may not be possible to define accurately the extent of the original infestation. In such cases a considerable area covering the site is injected with carbon disulphide, using a large mechanical soil injector.

As a further precaution, potatoes are always grown the following year in any field or garden where there has been evidence of beetles breeding. This crop would act as a "trap" if, by any chance, beetles had survived, and is kept under close observation. In fact no beetles have ever been found in these circumstances.

Occurrences in 1947 Season More colonies of Colorado beetles were discovered in England in 1947 than in any previous year, and a considerable number of beetles reached the country

* Before the National Agricultural Advisory Service was established, supervision of the field work was undertaken mainly by the Ministry's Horticultural Inspectors in cooperation with the specialist advisory officers.

in the early part of the year with imports from the Continent. For the most part these beetles were found unassociated with potatoes, and will be considered separately before dealing with the occurrences of breeding colonies on potato crops discovered later in the season.

FINDS OF SINGLE BEETLES The great majority of the single beetles reported were found in the London area and in Kent, though the earliest discovery was at Darlington on March 20 in a crate of lettuce imported from the Perpignan district, in the south of France. The next was in London on March 29 on spinach, also from the south of France. Four beetles were reported in or near London during April; one with lettuce from Perpignan, one in a lorry loading empty crates which had contained lettuce from France, one of unknown origin on an empty sack, and one with lettuce imported from Holland. In early May there were finds of five single beetles on lettuce from Northern Italy and on May 12 one with cabbage from Northern France; seven more were found up to May 28 on such sites as "roadway," "back-door step," "washing on line," etc.

The last few days of May and the first few days of June were unusually warm and sunny and favourable for the movement of beetles. During this period finds were reported daily,* almost all in or near London; on one day 20 beetles were received at the Laboratory, in addition to 120 suspects. It is known that considerable flights of beetles took place on the Continent at this time, and a few beetles were picked up on beaches on the south-east coast. There is no evidence of beetles having flown directly to this country, and it is most unlikely that any did so, but a number undoubtedly came down in the sea and a few were washed up on our coast. This also occurred in Jersey on a larger scale about the same time.†

Finds of single beetles in smaller numbers continued to be reported during July and August, and in late August and September more were found on beaches along the south-east coast. It is possible that a few of the scattered beetles found after the end of July may have been home-bred. Some were also discovered on ships from Continental ports, the largest number being on September 9, when nine beetles were found on a steamship which had arrived in London from Ghent.

In all, 224 single beetles were reported during the year. The distribution of the single beetles discovered up to the end of June corresponded well with the distribution of imported vegetable produce. They extended from the ports of Dover and Folkestone, through Kent to London and its suburbs and a few were conveyed as far as the midland and northern cities (see Fig. 1). It is certain that these beetles were brought to this country in cross-Channel shipping, and most of them probably with horticultural produce before the date on which the further restrictions on imports of vegetables, imposed by the Importation of Plants Order of 1947, came into force. Imports were on a larger scale than normally and continued later than was originally intended because of the unprecedented shortage of home-grown vegetables, due to the severe winter. Not all the beetles, however, came with vegetable imports; some were found on ships carrying general cargo of all kinds. Check inspections were carried out at Channel ports, but it is manifestly impossible to examine in detail all cargoes arriving from the Continent.

---

* About this time a daily newspaper made an offer of a reward of £10 for every Colorado beetle found in this country. Following representations by the Ministry, the offer was quickly withdrawn but not before two persons arriving from the Continent had been detected with live Colorado beetles in their possession. They were prosecuted and fined.

† See *Agriculture* (March, 1948), **54**, 569.

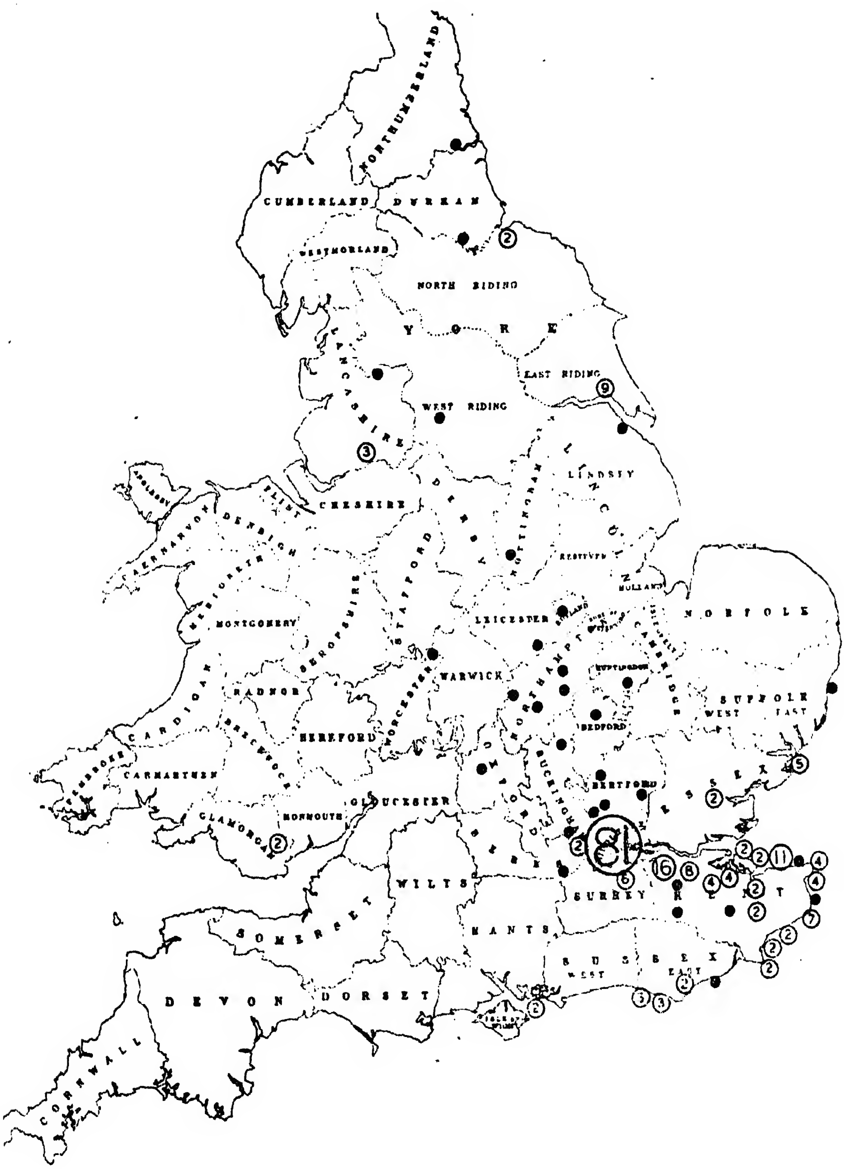


Fig. 1. Map showing finds of isolated adult Colorado beetles in 1947 (black dots indicate one beetle; figures within circles indicate number of separate beetles).

Breeding Colonies The first instance of Colorado beetle breeding in 1947 was discovered on May 28 at Dover, when a beetle which had laid a single egg-mass was found by a coastguard on a potato plant in his garden above the harbour. No further trace of eggs or larvae was found in the garden or in the neighbourhood.

On June 6 a farm worker reported that two beetles had been found on self-sown plants in a field that had grown potatoes in 1946, at Betsham, near Dartford, Kent. On searching the field carefully, one more was found and on June 10 another with eggs and newly hatched larvae. The field was searched on five more days and then thoroughly dusted with a DDT insecticide. In all, 7 beetles and a number of eggs and larvae were detected on this site.

On June 13 two beetles which had been discovered on allotments at Hartlip, Kent, were handed in to the local police. The allotments were visited the same day and eggs and larvae were found. The potatoes were kept under constant observation and 2 more beetles, 14 egg batches and numerous very young larvae were found. All potatoes on the allotments were dusted with a DDT insecticide and no further beetles, grubs or eggs were discovered.

In these two cases (Dartford and Hartlip) beetles had almost certainly overwintered here. They were no doubt the progeny of colonies undetected in the preceding year. Both were about half a mile outside the southern limit of an area which had been thoroughly searched and sprayed in 1946.

The first reports of beetles breeding further west and north were received on June 20 from allotment growers at Teddington, Middlesex, and New Bradwell, Bucks. In the latter instance, half-grown larvae, smaller larvae, newly hatched larvae, eggs and one female beetle were found, all in one line across the allotments. Subsequent findings, up to the last few days of July, were nearly all of this type, i.e., small colonies of eggs and larvae, evidently the progeny of one adult female which had arrived in the field from an outside source.

The first adults of the new generation emerging from the soil were reported on July 30 from allotments at Grays, Essex, and from two centres in Kent. Eggs of the new generation were first found on August 1 and larvae about ten days later. It is theoretically possible that in 1947 a few second generation beetles might have been bred from these larvae. There is, however, no definite record of second generation beetles having been found in the field, and, since 1947 was an exceptionally favourable year for the beetle, it may be said that Colorado beetle would normally have one gener-

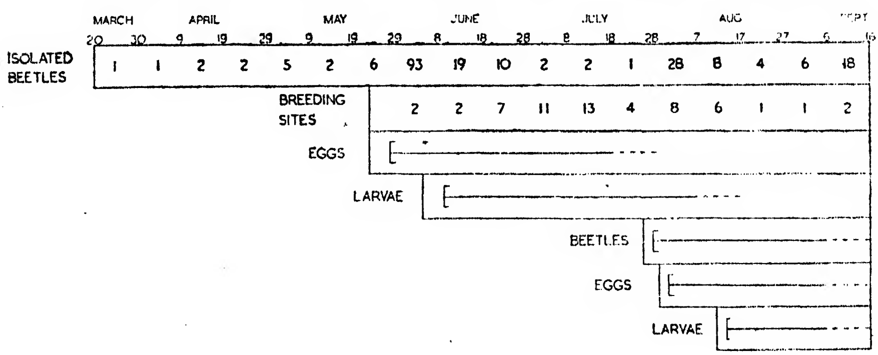


Fig. 2. Diagram showing the approximate dates in 1947 when single isolated Colorado beetles and colonies breeding on potatoes were found; also the periods during which eggs, grubs and adult beetles occurred.

ation in this country, though a partial second appears to be possible under the most favourable conditions. Fig. 2 shows diagrammatically the periods during which eggs, larvae and adult beetles occurred on the breeding sites, and also indicates the approximate dates on which both single isolated beetles and breeding colonies were discovered throughout the season.

The methods adopted in dealing with all the discoveries of breeding colonies were those outlined on pp. 56–7. Carbon disulphide was injected by hand in all but two instances. One was at Bearstead, Kent, where eight beetles only were found at the end of August, but there were signs that many more larvae had fed on the haulm. Two small plots were injected by hand and, when the crop had been lifted, the whole field, about an acre in extent, was treated with the tractor-drawn machine. The second instance was at East Farleigh, near Maidstone, where, following the injection of a small plot by hand, it was considered necessary to treat some 4 acres with the tractor-drawn machine because it was not possible to define precisely the location of the original colony or colonies.

In all, there were 57 occurrences of the pest breeding on potatoes reported during the year, of which 33 were in Kent. The colonies ranged from some half a dozen larvae with only one or two plants affected, to the largest occurrence at Tonbridge, Kent, where some 250 beetles were collected and many larvae were present. Included in the total are three instances of single beetles being found when lifting maincrop potatoes, there being no direct evidence of a colony having been present. It must, however, be presumed that breeding took place earlier in the year, although it is possible that the beetles came from elsewhere. Potatoes will be grown on these fields in 1948 to act as "traps" and will be kept under close observation. The distribution of the discoveries of breeding colonies (with the exception of a small occurrence in a garden near Radstock, Somerset) is shown in Fig. 3 (see p. 62).

Spraying Campaign A total of 10,866 acres of potatoes were sprayed or dusted; of this, 4,272 acres were planned "precautionary" spraying around the 1946 occurrences and near the most vulnerable ports and aerodromes. About 1,900 acres were dusted with 5 per cent DDT dust; most of the remainder was sprayed with lead arsenate, though a wettable DDT powder was also used on a small acreage. Fifteen tractor-mounted spraying machines and four tractor-mounted dusters were employed, in addition to a number of hand sprayers and dusters. All operators were given a course of instruction by Plant Protection Ltd.

The temporary inspectors searched some 5,000 acres, at an average of 3½ acres per man day. As in the past this work was invaluable and a number of field cases were discovered as a result of their search.

Continued Vigilance The year 1947 was unusually favourable for the development of Colorado beetle, as well as of many other insect pests. The beetle multiplied to large numbers in many parts of the Continent and was abundant on the coasts of France and Belgium. It was not surprising, therefore, that a number of the beetles reached south-eastern England during the periods when the adult insects are active and that some succeeded in starting infestations in our potato fields. It can, however, be regarded as satisfactory that none was found in the fenland potato-growing area, where there were one or two small occurrences in 1946. Special attention was given to searching potato crops near these places and a considerable acreage was sprayed or dusted.

Further occurrences of Colorado beetle must be expected this year, and plans are complete for spraying or dusting potato crops over much larger

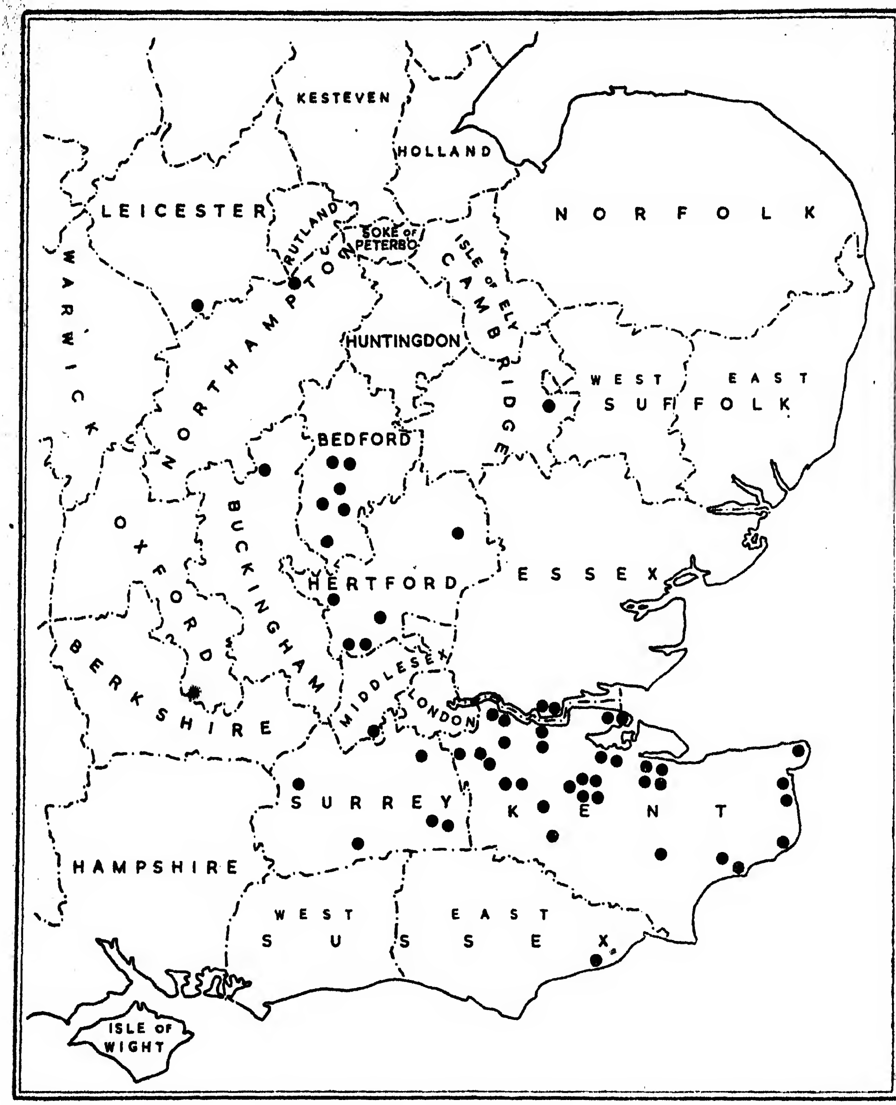


Fig. 3. Map showing location of breeding colonies of Colorado beetle found in 1947.

areas than hitherto. Success in stamping out this pest where it is found and in preventing its establishment in the country depends to a great extent on prompt notification of any discoveries. Once again, therefore, the Ministry urges all potato growers to watch for any sign of damage to their crops. Any yellowish beetle about $\frac{1}{2}$ inch long, with black stripes running up and down the body—not across—and any red or reddish-yellow grub found on potato leaves, should be placed with a piece of potato leaf in a tin box without holes and sent to the Plant Pathology Laboratory, Ministry of Agriculture, Milton Road, Harpenden, Herts, with a letter stating the exact place where it was found and the name and address of the sender. Nothing more should be done until instructions are received from the Ministry. Unauthorized

spraying or other treatment may cause the beetles to spread. Illustrated leaflets and posters are supplied free by the Ministry of Agriculture, Government Buildings (Block C), Lytham St. Annes, Lancs.

The success that has so far been achieved in this campaign has been due to the splendid cooperation with the Ministry's officers of the general public, farmers and farm workers, growers whose potato crops had to receive special attention, allotment-holders, temporary inspectors, and the police, and to the excellent work of the officers and staff of Plant Protection Ltd.

Photographs taken during the campaign against Colorado Beetle last year are illustrated on pp. ii-iii of the art inset.

1. Tractor-mounted dusting machine in operation.
2. Opening up an infested plot.
3. A breeding site after treatment. The potatoes have been lifted on the area affected, and the soil, as well as the surrounding rows of potatoes, dusted with an insecticide.
4. Injection of carbon disulphide by hand.

The photographs were taken and the text figures prepared by Messrs. W. F. Buck and H. W. Janson of the Ministry's Plant Pathology Laboratory.

THE GROWTH AND BOLTING OF MAY KING LETTUCE

ROWLAND MARCUS WOODMAN

Horticultural Research Station, School of Agriculture, Cambridge

RESEARCH work carried out on the growth and bolting of lettuces includes the following. Tincker (1933, 1938) (1,2) observed that supplementary light without heat increased vegetative growth of lettuces under winter conditions, and that under summer conditions there were distinct varietal peculiarities in response to light period, Early Paris and Stanstead Park, for instance, responding to increased photoperiod by a quicker development of flower stalks, and to decreased length of day by increased vegetative development. Rudorf and Stelzner (1934)(3) exposed lettuces to different periods of day-length from 8 to 16.5 hours, and found that summer varieties did not respond but that winter and forcing types showed a diminished tendency to run to seed with shorter day-length.

Bewley (1935)(4) demonstrated that Cheshunt Early Giant was a short-day plant and might bolt if planted before mid-September, and that temperatures of about 65°F. tended to cause spring lettuces to bolt. Reimers (1939)(5) and Allard and Garner (1940)(6) discussed the effect of length of day on different varieties of lettuce. Thompson (1940)(7) noted that lettuce runs to seed at high temperatures, and that increased length of day does not

hasten this, but that the rate of growth of the stem is accentuated once the flower stalk has started. Milthorpe and Horowitz (1943)(8) demonstrated that lettuces that had germinated at high temperatures and grown at low ones were larger, but that low temperatures during germination and the initial stages of growth stimulated seeding.

Claypool (1932)(9) stated that nitrogen was the most important fertilizer for the formation of lettuce heads and seed; phosphorus plus nitrogen was beneficial, but the addition of potassium to these two did not increase the yields of lettuce and seed. Phosphorus plus nitrogen also caused earlier maturity than nitrogen alone, or than nitrogen plus potassium.

Woodman was concerned chiefly with the effect of fertilizer treatment on hearting and on the yield of lettuce at the marketable stage. Phosphate (Woodman, 1939, 1940, 1944)(10,11,12) encouraged yield and early maturity of May King and Cheshunt Early Giant lettuces grown in sand, and prevented the appearance of purple tints on the former; nitrate (Woodman, 1939, 1940, 1944) (13,11,12) also favoured yield and early hearting of May King lettuce grown in sand; while potassium sulphate (Woodman, 1939, 1939, 1940, 1944) (14,15,11,12), over a wide range of concentrations, caused little increase in yield of May King and Cheshunt Early Giant lettuces, as was the experience of Claypool, and did not induce earlier maturity as shown by hearting up. Woodman (16) also demonstrated that for May King lettuce grown in sand with six nutrient solutions varying in concentration of nitrogen as sodium nitrate from 8.24–98.88 p.p.m. of N, phosphorus as disodium phosphate from 5.46-65.52 p.p.m. of P, and potassium as the sulphate from 5.61-67.32 p.p.m. of K, the nutrient elements always being present in the fixed proportions N : P : K=98.88 : 65.52 : 67.52, that solution having the absolute amounts of these three elements N=32.96 p.p.m., P=21.84 p.p.m., and K=22.44 p.p.m. was the optimum one as judged by size, appearance, and earliness of maturity of the lettuces. Mixtures of fertilizers containing high nitrogen, and nitrogen alone, but not phosphate or potash alone, gave the best response in yield of May King lettuce on a gravel soil (Woodman, 1942)(17).

Experimental This article describes the effects of the time of sowing, and of the extent and method of watering on the growth and bolting of May King lettuce grown in a gravel soil of known analysis in the unheated greenhouse. The soil was contained in 9-inch plant pots, waxed so that evaporation through the sides was retarded.

There were 324 pots, divided into 12 equal groups of 27 each. Each group of 27 was sown at one of 12 periodic sowings covering a full period of a year, the dates of sowing, given in Table 1, being so arranged as to be more frequent in the quick-growing season, e.g., May, and less frequent in seasons of slow growth, e.g., November to March.

The 27 pots at each sowing were subdivided into three equal sets of nine; one set received 100 c.c. of water on Mondays, Wednesdays and Fridays, this constituting the low level of water, w_1; another set received 200 c.c. of water at the same times, this constituting the high level of water, w_2; while the third set received a volume of water once a fortnight equal to the total volume 600 c.c., received in a fortnight for the low level of water, w_1, this set of pots thus constituting a treatment with alternate saturation and drought, w_3. At some seasons of the year the absolute amounts of water applied to the pots had naturally to be varied, but the relative proportions existing between w_1, w_2 and w_3 were always maintained constant. The division into the twelve times of sowing and the three methods of watering used at each sowing thus gave 3 × 12=36 treatments of nine pots or replicates a treat-

ment. The pots were then randomized in the unheated greenhouse so that a randomized-block arrangement of nine blocks of the 36 treatments was obtained. The full details and the statistical methods employed are described elsewhere (Woodman and Johnson, 1946, 1947)([18,19]).

A few seeds of May King lettuce were sown centrally in each of the 27 pots used at a sowing, and the resulting seedlings were singled as soon as practicable. Every lettuce was allowed to grow until it showed the first definite signs of bolting, when it was cut off just below the head, whether it had hearted or not, and was weighed in grams (28 g.=1 oz.).

Discussion of Results The 36 average weights (technically called the treatment means for yield) given in Table 1 are the averages of the weights of the nine lettuces constituting each treatment; the figure in parentheses under each average weight or treatment mean is the total number of lettuces, out of the possible nine, that had hearted for the particular treatment concerned.

Table 1

Method of Watering	Average Wt. of Lettuces per Treatment (in Grams) for Date of Sowing											
	May 5 1944	May 17 1944	May 31 1944	June 16 1944	July 3 1944	Aug. 2 1944	Sept. 4 1944	Oct. 16 1944	Nov. 27 1944	Jan. 16 1945	Mar. 2 1945	Apr. 4 1945
w_1	18 (0)	16 (0)	12 (0)	12 (0)	19 (0)	85 (8)	73 (9)	59 (7)	74 (9)	54 (1)	71 (0)	60 (0)
w_2	28 (0)	38 (0)	44 (0)	30 (0)	24 (0)	125 (9)	90 (9)	108 (8)	121 (9)	96 (9)	141 (9)	111 (0)
w_3	21 (0)	22 (0)	28 (0)	23 (0)	17 (0)	95 (9)	62 (9)	52 (7)	72 (9)	52 (0)	69 (0)	43 (0)

The following inferences may be drawn from Table 1: (1) Lettuces sown in April to early July all bolted without hearting, whereas those sown in August to November hearted before bolting. The high level of water, w_2 definitely delayed bolting and encouraged hearting of the lettuces sown in January to March; thus all 18 lettuces for w_2 and times of sowing January 16 and March 2 hearted, but only one lettuce out of a possible 36 hearted for these two sowings and methods of watering w_1 and w_3.

(2) The average weights of lettuces sown from early May to early July were poor for all methods of watering, although there was some bias in favour of the high level of water, w_2, even with these bolters, as shown by the greater weights in Table 1 for w_2 for all five times of sowing. Yields were high for the period August 2 to March 2, especially for the high level of water, w_2; the low level of water w_1, and alternate saturation and drought, w_3, caused for each sowing smaller and approximately equal yields. The yields were also large for the sowing on April 4, especially for w_2 (111 g.); even though none of the 27 for this sowing hearted before bolting, the high level of water w_2 was noticed to cause all nine lettuces to commence to turn in before bolting, while only one for w_1 and two for w_3 did so.

It was also found (the actual data are not included here) that September to November sowings gave the oldest lettuces reckoned in days from germination to bolting, January and August sowings the next oldest, and March to early July sowings the youngest. The greatest average weight of lettuce was obtained with the older lettuces, and the smallest for those with the shortest lives sown in March to early July; water, in general, had no effect on length of life, although the high level, w_2, gave the greatest yield for any time of sowing (Table 1). Similar results were obtained when the life of the

lettuce was expressed in actual light-hours or hours of daylight. Thus September to November sowings resulted in the longest life in light-hours, the largest weights of heads, and hearting before bolting, this period being the best for sowing May King lettuce in a gravel soil in the unheated greenhouse. August sowings were also good.

Large heads and hearting were, in general, obtained when growth occurred during short days and in cool periods of mean temperature less than 60° F. Thus sowings made from August to March, with average temperatures below 60° F. and growth taking place during a period of short days, resulted in large heads, ability to heart, and long life from germination to bolting calculated either in days or in hours of daylight.

Mature lettuces receiving a low level of water were definitely darker in colour than those receiving a high level.

Table 2 presents data arranged for monthly periods of harvest irrespective of time of sowing or method of watering. The first column shows the monthly periods of harvest; the second the total numbers of lettuces bolting in these periods irrespective of treatment; the third the average weight of all the lettuces bolting in the periods; the fourth the average age of these lettuces in days from germination to first signs of bolting (i.e., to time of harvest); and the last column the average age in hours of daylight.

The table demonstrates, for the series of sowings made, that the total numbers of lettuces bolting irrespective of time of sowing or method of watering were greatest in May to July.

Table 2.

PERIOD OF HARVEST	Total no of lettuces bolting in the period	Average wt of all lettuces harvested in the period	Average age in days of lettuces harvested during the period	Average age in light-hours of lettuces harvested during the period
July 3-31, 1944	91	26	46	755
July 31-Aug 28, 1944	35	19	40	626
Aug. 28- Sept 25, 1944	9	19	60	880
Sept. 25-Oct 23, 1944	1	22	59	771
Oct 23-Nov 20, 1944	11	115	99	1,194
Nov. 20-Dec 18, 1944	13	95	113	1,299
Dec. 18, 1944-Jan 15, 1945	3	97	128	1,369
Jan 15-Feb 12, 1945	2	63	145	1,370
Feb 12-Mar 12, 1945	8	47	164	1,542
Mar. 12-Apr 9, 1945	11	61	195	1,914
Apr. 9-May 7, 1945	9	97	223	2,284
May 7-June 4, 1945	102	83	132	1,565
June 4-18, 1945	29	71	76	1,072

This period of maximum bolting was found to coincide with average weekly temperatures greater than about 60° F. and with the longest days reckoned in hours of daylight. At the beginning of this period, in May, the average life of the harvested lettuces from germination to first signs of bolting, expressed either in days (132) or in light-hours (1,565) was large, but rapidly decreased as the end of the period was reached in July (46 days and 755 light-hours, respectively). Lettuces harvested from October to the end of May, with the exception of those few harvested from mid-January to the end of March, possessed the greatest average weight, and this period was generally one of low temperatures (from 29°—60° F.), short days, and increasing age calculated either in days or in light-hours. Lettuces of all

treatments harvested because of signs of bolting from mid-October to mid-January were in general the heaviest, and were grown in a short time; these lettuces were sown in August.

References

1. TINCKER (1933) *Gdnrs' Chron.* Ser. 3, **93** 404.
2. TINCKER (1938) *Sci. Hort.* **6** 133.
3. RUDORF and STELZNER (1934) *Gartenbauwiss,* **9** 142, 194.
4. BEWLEY (1935) *Ann. Rep. Res. Sta. Cheshunt,* **21** 33.
5. REIMERS (1939) *C. R. Acad. Sci. U.R.S.S.,* **25** 790.
6. ALLARD and GARNER (1940) *Tech. Bull. U.S. Dept. Agric.,* **727** 64.
7. THOMPSON (1940) *Minn. Hort.,* **68** 163.
8. MILTHORPE and HOROWITZ (1943) *Agric. Gaz. N.S.W.,* **54** 53.
9. CLAYPOOL (1932) *Proc. Amer. Soc. Hort. Sci.,* **29** 438.
10. WOODMAN (1939) *J. Agric. Sci.,* **29** 229.
11. WOODMAN (1940) *Ann. Appl. Biol.,* **27** 5.
12. WOODMAN (1944) *Ann. Appl. Biol.,* **31** 22.
13. WOODMAN (1939) *Ann. Bot., Lond.* (*N.S.*), **3** 649.
14. WOODMAN (1939) *J. Pomology,* **17** 167.
15. WOODMAN (1939) *Soil Sci.,* **48** 101.
16. WOODMAN (1940) *Ann. Appl. Biol.,* **27** 445.
17. WOODMAN (1942) *Ann. Appl. Biol.,* **29** 213.
18. WOODMAN and JOHNSON (1946) *J. Agric. Sci.,* **36** 80.
19. WOODMAN and JOHNSON (1947) *J. Agric. Sci.,* **37** 95.

BALING FOR BETTER HAY

W. A. HAYLES

National Agricultural Advisory Service, East Suffolk

THE recent introduction of one-man automatic twine-tying balers is an important step towards further mechanization of haymaking. Baling in the field should give a product of higher feeding value than the ordinary method and facilitate subsequent handling and distribution. The collection and baling of hay with the hand-tied, wire-type of baler was rather slower than the traditional method of carting and stacking. The factor limiting the throughput with this type of machine, whether stationary or pick-up, was the speed at which the bales could be wired by hand. It has now been shown that one man with the automatic twine-tying baler can bale, from the windrow, up to 4 tons of hay per hour in the form of well-shaped, medium-density bales.

Earlier Stacking Provided that after baling the moisture is allowed to dry out from these small units, hay may safely be baled at moisture contents higher than those at which it would be safe to put it in the stack. Hay that is fit to stack has a moisture content of approximately 24 per cent; this will slowly dry out in the stack to about 15 per cent. If the bales are of the correct density, and stacked properly, hay can safely be baled when the moisture content is 30 per cent, or about one day sooner than it would be fit to stack in good haymaking weather. Thus loss of leafy parts, due to over-drying and shattering, and the risk

of damage from rain and sun, are minimized. Once fit to pick up, the hay can quickly be stacked.

Hay baling is sometimes condemned—usually after a failure with a wire-tying baler. Heating and moulding in the bale in almost every instance can be traced to one or more of the following causes: baling when the hay is too moist inside or contains outside moisture in the form of rain or dew; baling too tightly; or stacking the bales without making provision for heat and moisture to escape. When baling hay less dry than is customary for stacking loose, it is essential for the density or tightness of the bale to be related directly to the moisture content of the hay. The greater the moisture the looser the bale should be in order that the sap moisture can escape without undue heating; the lower limit in this direction is when the bale is so loose that the wires or cords tend to fall off Bale density is calculated by dividing the weight of the bale (in lb.) by its capacity (in cu. feet). The table below sets out the bale weights of different sized bales for hay of various moisture contents.

	Moisture content	Size of baling chamber	Max. wt. of 3-ft. long bale	Corresponding density	For every inch above or below 36 inches add or subtract
	per cent	*in.*	*lb.*	*lb. per cu. ft.*	*lb.*
Hay 2 days before stacking condition	30–34	14×18	47	9	1
		16×18	54		1½
		17×22	70		2
		18×22	74		2
Hay 1 day before stacking condition	26–30	14×18	63	12	1¾
		16×18	72		2
		17×22	94		2½
		18×22	99		2¾
Hay in stacking condition	22–26	14×18	79	15	2¼
		16×18	90		2½
		17×22	117		3¼
		18×22	124		3½

For example, if the hay is being baled one day before it would be fit to put in a stack, and the baler has a cross-section of 14 × 18 inches, a bale 36 inches long should weigh not more than 63 lb. If heavier the density should be reduced by slacking the tensioning device at the end of the baling chamber. After such an adjustment has been carried out, at least five bales should be made before the weight is checked again.

To obtain full benefit from baling the swath should be turned after wilting and, if necessary, two or more swaths run together for a windrow. When a pick-up baler is being used the size and shape of the windrow should receive careful consideration, since, to some extent, this will determine the speed at which the baler can work over the ground. For the best results the windrow should be of uniform size and contain hay that is evenly dried throughout without trace of outside moisture. Whenever possible the swath-turner and the baler should follow the same direction as the mower.

If the bales have been left lying where dropped they can be loaded on to a trailer either by hand or by a modified elevator. The most recent American types of loader pick up and load the bales to the side of a lorry or trailer. Rapid increases in the number of pick-up balers in use in this country may lead to the production of such units here. At times it may be desirable to cart the bales right out of the field or to drop them in heaps at convenient intervals in the field for subsequent loading. This may best be achieved by towing a low trailer or sledge behind the baler and allowing the bales to be pushed up on the trailer by the action of the ram. A man

is needed to receive and stack the bales on the trailer; with the automatic tying baler he can also keep a look-out for any untied bales due to failure of the tying mechanism.

If the weather is fine and hay has been baled on the quick side, the bales can be left standing on their ends in the field for a few days to lose the greater part of their sap moisture. If there is a risk of rain it may be advisable to get them under cover as soon as possible.

Stacking The stack, which for preference should be long and narrow to allow a more convenient "break in," can be built, a few layers at a time, either in the open or under a Dutch barn. With rectangular bales the aim in either case should be to provide sufficient space between the bales for good air circulation from bottom to top, thus allowing heat and moisture to escape freely. The bales in each layer should be stacked resting on their narrow sides, placed rough side to smooth side, with a 4-inch space between each bale. The lengthwise direction of the bales should be at right angles to the bales below, thus providing a bond to tie the stack together. This applies particularly to bales made with a ram-type baler. With a press-type baler the bales are best stacked as closely as they will go. For stacking bales of both kinds, a good bottom is essential—one formed of substantial rough timbers keeping the bales clear of the ground. When the heating stage is over, about 14 days, the stack can be topped up either with bales or straw, and thatched in the usual way.

At the present time two outstanding difficulties confront the farmer who wishes to adopt this method of making hay: the high capital cost of the automatic twine-tying baler, £350 to £850, and the restricted supply of these machines. On economic grounds it would be necessary to bale at least 250 tons per year to justify an expenditure of £850. The rapid increase in the number of combine harvesters in use may well assist a good many pick-up balers to earn their keep by baling straw behind such machines. They can also be used as stationary balers behind threshing drums, and as such they are quite capable of handling the normal output of a 54-inch drum. For at least some time to come, it would appear that the small farmer who wishes to take advantage of this method of making hay or collecting straw, will have to rely on the contractor.

Sweep and Stationary Baling The stationary machine is a high-density type of baler, usually driven from the pulley of a tractor. The crop is brought to the baler by sweeps and elevated or pitched on to the feeding platform. Wiring up the bales is a hand process; the length of the bale being determined by the position at which the board is dropped or the grooved baling needle inserted. Density of bales is controlled by the clamp screws at the end of the baling chamber. In addition to the labour required for sweeping, at least five men will be needed to operate the baler, two feeding and one stacking the bales, while the throughput will be controlled by the speed at which the other two men can wire up the bales. An output of 2–2½ tons per hour can be obtained if the feeding is even.

Automatic Twine-Tying Pick-up Press This is a machine which ties up a low-density bale; it is usually driven from the p.t.o. of the tractor which hauls the baler. The crop is collected from the windrow by a pick-up attachment and elevated to the hopper, where it is compressed by a light piston. The bales are compressed on their sides and automatically tied with two or three bonds of binder twine. The density of the bales is controlled by an adjustable

screw clamp. As the bales from this type of machine are of much lower density than those from a wire-tying baler, they do not keep such a good shape, and there is little risk of baling too tightly if the hay is anything like fit to collect. No operator is required on the baler, and one man with the tractor can give a steady output of 1½ tons per hour.

Hand-Wiring Pick-up Baler This machine, which makes a high-density bale, is engine-driven, and can be hauled by a medium-powered tractor. The crop is collected from the windrow by the pick-up attachment and elevated to the cross-conveyor which delivers it into the baling chamber. As with the stationary machine, bale separation is obtained by the baling board or needle, the wires being threaded and made fast by hand in each case. By stopping or reversing the cross feed, the hay stream to the baling chamber can be interrupted while a board is dropped. Bale density is controlled by screws at the end of the baling chamber. A minimum of four persons will be needed to operate the outfit, one to drive the tractor, one to drop spacing boards, and two to wire bales. As with the stationary baler, speed of working will be controlled by the speed at which bales can be wired up : 1½ to 2 tons per hour, according to size, is the average output from this type of machine.

Automatic Twine-Tying Pick-up Baler This is an engine-driven machine which produces a well-shaped medium-density bale, tied with two bonds of baler twine. Hay is collected from the windrow and elevated to the cross-conveyor, which carries it into the baling chamber. The ram is fitted with a knife on its outer edge, which completely severs the hay in the baling chamber from that in the cross-conveyor at each packing stroke ; this gives the outside of the bale a clean appearance and, as each charge is sliced, the bale is more readily broken down for feeding purposes. Bale separation is provided by the operation of the pair of needles which can be set to tie bales of a pre-determined length, usually covering the range 27–42 inches, with 36 inches as a standard length. The length of the bale is measured by a metering wheel which automatically sets the tying mechanism in motion when the set length is reached, thus providing bales of uniform length. Bale density is controlled by screws at the end of the bale chamber. One man to drive the light tractor required to haul the machine can bale up to 3–4 tons per hour.

Another type of one-man baler, a few of which will be imported this year, picks up the hay from the windrow, spreads it out into a mat and rolls it into tight cylindrical bales. The bales are automatically wrapped with binder twine to prevent them unrolling. With this machine, which is p.t.o. driven, it is necessary to stop for about five seconds each time a bale is discharged. One man driving the tractor can give an output of 3–4 tons per hour.

See illustrations on p.iv of the art inset.

BRITISH PEATS

G. K. Fraser, M.A., D.Sc.
Macaulay Institute for Soil Research, Aberdeen

In the early days of the scientific study of soils the question of what gave rise to peat was one of considerable speculation. With a greater knowledge of the processes which determine the growth and decay of vegetable matter, most of the curious theories once put forward are now forgotten and a reasonable account of the chief factors involved in the growth of peat can be given.

How Peat is Formed Two of the major requirements for plant growth are air and water. Each tends to interfere with the other in the soil; if there is too much water there is too little air, and if there is too much air the soil becomes too dry. Peat is formed as a result of excessive water or insufficient air. Insufficient air in the soil has a greater effect on those organisms which are confined to the soil, e.g., bacteria and fungi, than it has on many of the ordinary green plants, which have special means of conducting air (or oxygen) from their aerial parts to their roots, or which can place their roots in such a position between air and water that they get enough of both for their needs. The micro-organisms (especially the bacteria and fungi) which are responsible for the decay of the dead plant material are prevented from bringing about decay in plant refuse which falls into stagnant water. Thus in soil which is waterlogged, or in water which is sufficiently stagnant to prevent aeration, the rate of the growth of plants is greater than the rate at which their remains rot, and waterlogged, half-rotted vegetable matter tends to accumulate, i.e., peat begins to form.

Other conditions may play an important part. For example, where the fertility of the soil or water involved is high, a rank growth of vegetation occurs—as in fenlands; where these are poor only slow-growing plants can grow, as in sphagnum bogs or hill peats. Under the former conditions the rate of peat formation may be rapid; under the latter it is slow. But the material of which the plants are composed is also of some consequence in relation to decay. Anyone who has made a mixed compost will have noted this. Ordinary garden weeds, brassicas, and the like, rot down very quickly, while beech leaves or conifer needles decay very slowly. Thus we find that plants growing in infertile, waterlogged soils and lakes not only grow more slowly but also decay more slowly.

In addition, many of these plants have structures which tend to keep them wet, whether alive or dead. The best example of this is, of course, sphagnum moss, which is very spongy and able to absorb and hold very large amounts of water, a property which makes sphagnum-moss peat the most useful type where an absorbent is required. When plants of this kind establish themselves on wet ground, they keep the surface waterlogged so long as enough rain falls upon them to keep them wet. We thus find that in regions of high rainfall, like the west coast of Britain and Ireland, and the north of Scotland, peat tends to form over wide areas which may not be badly drained in themselves, as are the southern and eastern peat lands, but on which the moorland vegetation itself produces a waterlogged surface. The same result arises from similar conditions on the wet and cold hill plateaux and mountain slopes throughout the whole country—in fact over the whole world.

Other conditions may affect peat accumulation; for example, temperature—for as with aeration, the micro-organisms of decay are more readily affected

by low summer temperatures than are plants: hence peat deposits are most abundant in those parts of the world where plants can grow but where also the activities of the microbes of decay are very low.

CHANGES OVER LONG PERIODS. When this process of peat accumulation has once begun, it continues indefinitely as long as the conditions which started the process are maintained, i.e., so long as the level of the ground water is such that refuse falling on the surface is kept from decaying by becoming waterlogged. But conditions do not remain quite the same over long periods. For example, the growth of the peat may lift it above the original ground water so that only the rain falling on it keeps it wet. Then the nature of the plants growing on it will change. Thus we find that in many of our low-ground peat mosses, although the upper part is formed of sphagnum mosses, bog cottons and heather, the lower layers are composed of reed grass remains, i.e., the peat started as a reed grass peat when the drainage water was richer, but became a sphagnum moss peat when, owing to continued growth, the surface was raised above the level of the richer ground water. In the end the peat may be raised so far above the source of plant nutrients that growth of herbage becomes impossible and the exposed peat is eroded into channels called hags. (Hags may, however, develop from other causes.) Should the surface of the peat become reasonably dry, then forest may grow upon it, and in many peat deposits layers of tree roots are found, indicating that, for a time at least, the ground was not so wet that trees were unable to grow.

In our deeper peat deposits the change from reed grass peat to moss peat is considered to be associated with changes in climate which have taken place since the Ice Age, rather than to any simple change due to the increasing depth of the peat deposit. Throughout Britain as a whole, peat growth has been taking place ever since the Ice Age, some ten thousand years ago. In some places it may have begun still earlier. Thus the deep peat deposits which are found in badly drained hollows, and which are as a rule of considerable depths (20 feet and more), represent plant growth over some thousands of years. The relationship between peat growth and climatic changes over this period is an interesting story into which we cannot go here. Suffice it to say that though in a general way the causes and modes of peat formation are simple, in detail they afford a very complex subject of study and provide much material evidence on the recent history of the surface of the land.

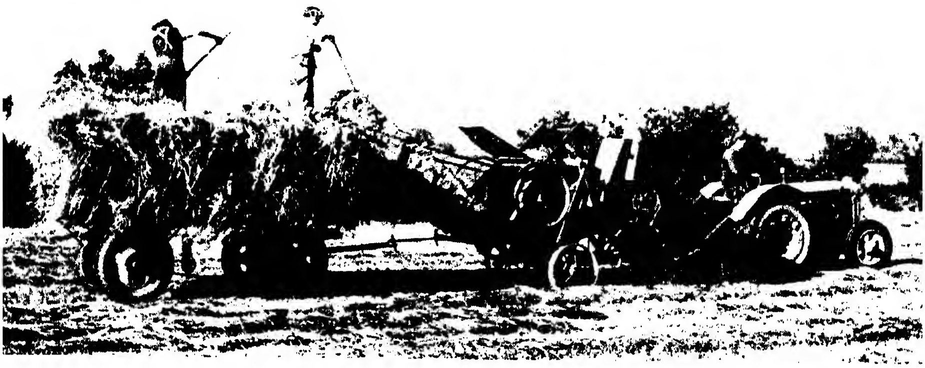
Basin Peat and Blanket Peat As can be concluded from what has been said, there are two major types of peat deposit:

(1) *Local deposits* which are formed in badly drained places, lakes and the like, in which marsh or lacustrine vegetable remains accumulate to such an extent that peat begins to form. These have been termed *Basin Peat* deposits and occur as local deposits among other types of soil. They are usually well over 10 feet in depth and show considerable changes in the nature of the peat from one level to another.

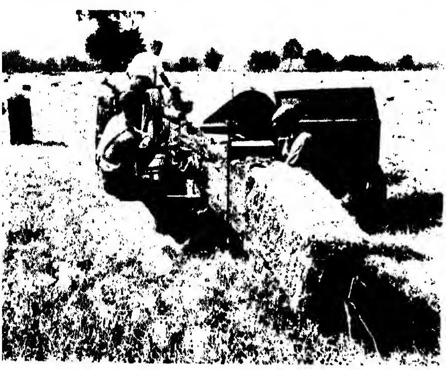
(2) *Regional deposits* which may cover wide areas, forming one of the commonest types of soil in the area. Because of this, these deposits are called *Blanket Peat.* Normally, blanket peat is less than 10 feet in depth, but wherever the surface off-run is poor it merges locally into basin peat. Normal blanket peat does not show striking changes in the nature of the peat from below upwards. Hill peat is of the same nature as blanket peat; the differences found are chiefly the result of the higher elevation at which

Peat Production in the West Country

Sweeping and baling hay with a stationary machine Photo, *Farmer and Stockbreeder*



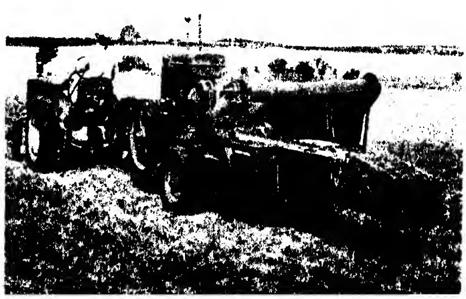
Automatic tying press pick-up baler Photo, *N.I.A.E.*



Hand-wiring pick-up baler

Photos, *N.I.A.E.*

Automatic twine-tying pick-up baler



it occurs, such as differences in vegetation, in rate of growth, lower winter temperatures, etc.

As is to be expected, peat deposits are found chiefly in the regions of high rainfall and low summer temperatures, but basin peats tend to extend along the drainage channels of the high rainfall hill areas to lower ground in which conditions are not so extreme. In Europe, for example, the major peat deposits are found along the north-western maritime countries (including Great Britain), but the further north we go, the more general becomes blanket peat, until arctic conditions reduce the rate of growth of plants below the point of peat formation. A similar sequence is found in this country. In the north-west of Scotland some 80 per cent of the surface of the island of Lewis is covered with peat, chiefly blanket peat, and in the county of Caithness, on the north-east, one-third of the total land surface.

In the central valley of Scotland only about one-third of 1 per cent of the total area is peat, while in the low-lying counties of central and south-eastern England the proportion is much less than that, even when the peat area of the fenlands is taken into consideration. But even in the south, peat deposits are much more abundant in the western counties, as they are in Wales, Yorkshire and Lancashire, and in the border counties, where, of course, hill peat is the most widespread. It is not possible to give exact figures of the areas of peat in each country, but as far as can be ascertained the following table is at least fairly accurate.

	Total area *sq. miles*	Area of Peat *sq. miles*	Percent of total
England and Wales	58,340	6000—6500	11
Scotland	30,410	2700—3000	9
Ireland	32,600	4700	14

Only in Ireland has a reasonably satisfactory survey of peat deposits been made. In all three countries the greatest area of peat is found in hill country; even in Ireland, where basin peat and lowland blanket peat are most widespread, nearly one-half of the total area is hill peat, and in England and Scotland the proportion of hill peat is undoubtedly much higher. In England there is probably little or no true blanket peat, except perhaps in the northern uplands. In Scotland, as has already been indicated, a great proportion of the northern and western peat is blanket moss.

Principal Types of Plants from which Peat is Formed It is impossible to do more than sketch the various types of vegetation from which peat has been formed, so that in these notes only those which have some special practical interest are indicated. All of these types are even now in process of forming peat at the surface of the ground in one part of the country or another, and the practical value of the peat formed is affected by the depth at which it occurs, as well as by the detailed conditions under which it has accumulated.

Moss Peats The most familiar peats in this country consist of sphagnum moss mixed with varying proportions of plants like the cottongrasses (*Eriophorum*), deer grass (*Scirpus caespitosus*), sedges (*Carex*) and heathers (*Calluna, Erica*). These peats are called in the trade "moss peats," and the more sphagnum a moss peat contains usually the more valuable it is for purposes where lightness of texture and absorptive power are required. Such peats are best used for two major purposes:

(a) *Soil conditioning*—where the peat is added to a mineral soil in order to improve, by its micro-structure, the power of absorbing water and, by

its irregular and loose texture, soil aeration. For this purpose pure sphagnum peats are the best, and the firmer the moss the better its quality.

(b) *Moss litter*—where the peat is used as a clean absorbent of urine and odours in stables, etc. Here the peat is usually sold in bales, and pure sphagnum peat is not quite so easily handled as sphagnum with cottongrass or sedge in mixture, since the fibres of these plants serve to bind the peat together into bales. Moss litter is a much better basis for manure than straw, since it can absorb much more liquid and nitrogenous waste, and gives a richer product than straw, and is free from weed seeds and plant diseases.

Where moss peat contains less sphagnum and more cottongrass, it has lower absorptive power, and if at the same time it contains much heather it becomes, when dry, hard and lumpy and is useful chiefly as fuel.

DEER GRASS (SCIRPUS) PEAT Peats formed under the wet climate of the north-west usually have as their major constituents deer grass and sphagnum along with varying amounts of the other moorland plants such as cottongrasses. As a result of the conditions of their formation, decomposition may be very slight, but an alteration in the character of the plant remains takes place so that when dried they form fairly or extremely compact, firm blocks. Thus they do not possess much of the absorptive power of the moss peats but resemble the more strongly decomposed and altered deep peats of the basin mosses. These peats therefore form good fuel, apart from the upper few inches, since, once dried, they can be handled easily without crumbling, breaking and forming dust. Hill peats are usually of this type but are more decomposed, blacker and more fibrous, since they usually contain large amounts of cottongrass and heather; they are amongst the best fuel peats.

REED GRASS (PHRAGMITES) AND SEDGE PEATS These peats form a group rather than one type, but are here noted because of their agricultural importance. Peat of this type is formed when the ground water is richer in plant nutrients than where moss peats are forming. Hence they represent a richer vegetation, and in typical fen regions contain much larger amounts of mineral nutrients (especially lime) than do the types already mentioned. Fen peat resembles stacked farmyard manure in appearance, although it consists chiefly of roots rather than the stems of reeds and grasses. In detail, like farmyard manure, the appearance changes with age and the degree of decomposition which has taken place. Thus when young and relatively slightly decomposed it may consist obviously of roots and straw interbedded, and may have a light colour. Usually it is darkened as a result of partial decomposition, even on the surface and, at more than a few feet in depth, it resembles in a general way dark, over-rotted straw manure.

It is inferior for the purposes for which moss peats, cottongrass and deer grass peats are used, since its absorptive power after drying is low and its cohesion poor. It does not form a high-grade fuel peat, and often contains so much woody and brush remains that when dried it falls to pieces.

On the other hand, when drained and cultivated it forms by far the most readily reclaimable peat land; in fact some of the best vegetable-growing soil in the Temperate Zone consists of this peat, a result partly of its richer basic character, and partly apparently because the way in which it weathers down is not unlike that of the organic matter of rich soil.

The other varieties of peat which occur are usually very similar to the major types listed above.

Whatever may be the vegetable origin of peat, when it has been decomposed and compacted (because of its age, the depth at which it lies, etc.) it

may form compact blocks when cut and dried. It is then of use chiefly as a fuel peat. The lowest layers of most deep peat deposits are of this category.

Peat is made use of along two lines : (a) it is removed, dried and used for various purposes, or (b) it is reclaimed, i.e., it is converted in mass into a useful soil for agricultural or horticultural purposes.

The winning and drying of peat is carried out either by hand or by mechanical methods. The preliminary work for both these operations consists of draining the area to be worked in the next few years, so as to dry the peat as much as possible just as it lies.

Cutting—By Hand and Machine In the cutting of peat by hand labour, the surface turf is skinned off, and a bank is formed 3-6 feet in depth by about 4 feet in width, for example, along a ditch. The methods and tools in use vary with custom, which is usually related to the character of the peat ; for example, although the most customary "peat" is brick-like in shape, where the climate is wetter, as in the West Highlands of Scotland, the peat is cut in broad, thin slabs, in order to accelerate drying. The cutter usually stands facing the bank and cuts out the peats by pushing a lugged spade horizontally into the bank. But there are many variations, and the peats may be cut out vertically or at a slope, either across or along the top of the bank. They are then spread out to dry on the surface of the bog and afterwards piled in small stacks of some half-dozen pieces. These are turned occasionally to obtain even drying, and are usually stacked loosely before being carted off for storage. It is obvious that a large area is required to dry the peats, especially in the preliminary stages. The cutting and handling of the peats on the moss is a very time-consuming job.

In order to reduce the labour and the cost of hand cutting, various types of machines have been developed. It is found, however, that the cost of machine cutting and handling is not so very much less than are the simpler methods, although the various methods practised have their advantages under special conditions. Earlier machines simply mechanized the procedure in use by hand cutting. Then the object has been to pulp the peat during or following excavation, when it gives a more even product and dries more rapidly. For economic working a very long bank is necessary, with, of course a very great drying area. Here, naturally, the peat is used only as fuel. The most modern type of peat harvester is planned along different lines. With it, a large area of the moss is cleared of turf and levelled, and the peat at the surface is, so to speak, mowed off in thin cuts, just as a lawn is mowed. The granular mowings are thrown out behind the cutter and dry very quickly. as compared with blocks of peat, so that in reasonably dry weather they may be raked together and stored for further processing in one day or so ; or the moss peat can be packed or baled for horticultural or agricultural use right away. This process can be repeated so long as the weather is dry.

On a large scale it seems certain that for most conditions mechanical winning of peat is more economic than hand winning, but the machines required and the rate of production necessary for their most economic use involve very heavy initial expenditure, and probably more money has been lost on schemes of peat manufacture than in most other processes of similar importance. On the other hand, even for small-scale operations the cutting of peats is not an occupation for which labour is readily available in most parts of the country.

The Uses of Peat After the peat is cut and dried the more dense peats are used as fuel, while the moss peats and litter peats are "willowed" or torn down to the most appropriate size for the purpose to

which the material is to be put. For example, most horticultural (soil "conditioner") peat is sold as granulated moss peat, graded between $\frac{1}{16}$-1 inch; moss litter is from 1-2 inches minimum size but should contain few actual lumps of 2 inches. Fine peat, often called moss meal or moss "mull," is sold for top-dressing lawns, etc.

In general, however, and especially at the present time, peat is thought of as a fuel, and then it is marketed either as peats (turves in Ireland), or is compressed into briquettes—for example, in the "one-day" process referred to above the dry cuttings are compressed into briquettes as the routine procedure for fuel production. Even when reasonably well air-dried, peat is inferior in heating power to coal, although it is claimed that with efficient drying and briquetting, peat can be made which is not much less efficient than household coal. Speaking generally, however, the best peats have about 75 per cent of the heating value of household coal or 50-55 per cent of that of steam coal. There is much more involved in the use of peat as fuel than the data upon which these figures are based. Light-textured, undecomposed peats have a lower practical value than coal or even wood, but compact black peats, such as are obtained from the lower layers of many basin peats, from blanket moss, and especially from hill peat, have greater heating value than timber as usually sold, and may approach ordinary coal in this respect. Under present conditions, when any additional source of fuel is welcome, peat is without doubt of very great importance as a supplement to coal—especially in outlying districts where freightage charges for coal are heavy. In modern times it has never been of greater importance than at present.

There are many other uses to which peat can be put. With regard to most of these, the critical point to be considered is the cost of production. For many of them this is bound up with a steady market for the peat used in the ways already discussed. Space does not allow mention of more than a few of these uses, such as distillation for by-products, electric power plant at the site of the deposit, wax extraction, coal gas purification, packing and insulating material.

A steady though small market exists for peat as a filler for cattle feed, for fish curing and whisky distillation, but the amount used for these is very small.

The second major use of peat deposits is reclamation of the peat area either (1) as it is, or (2) after the peat, or most of it, has been removed for fuel.

Peat Reclamation It is perhaps most helpful to review shortly this question of peat reclamation historically, since a good deal of the undoubted confusion with which it is discussed is the result of the past history of such work. The reclamation of some types of peat ground has gone on for centuries–for example the Paris market-garden industry was developed largely on peat ground, i.e., the fen peats and swamps surrounding the city and the river. In most countries where such deposits occur, there is a more or less continuous history of their reclamation, whether it be for green and root crops of the vegetable type, as is usual near towns, or for pasture in more outlying districts. There is here one fundamental necessity, namely, well-regulated drainage. Often on the flat lands on which fen peat occurs this means simply the avoidance of flooding. Occasionally, however, over-drainage may occur, and in modern systems of fen reclamation steps are usually taken to restrict off-run during dry seasons, for although peat retains water, if once over-dried it is difficult to re-wet, and if fallow, may suffer badly from wind erosion.

In our fenlands, that is, especially in eastern and southern England, reclamation has usually proceeded along satisfactory lines on the scale one would expect from individual landowners and farmers. On the Continent, however, land hunger has usually forced the State to play a greater part in reclamation schemes than has been usual here—at least until recent years, when thousands of acres have been reclaimed in various parts of the country as a war emergency measure. In such types of peat land, apart from water regulation, the greater liability to trouble from trace element deficiencies and regulation of acidity (pH) in some instances, the mode of farming is not remarkably different from that required in heavy mineral soils subject to flooding. The experiences and results achieved in recent years compare well with those of most fen reclamation schemes anywhere (the American "muck" soils are of the same general type).

The position is quite different as regards the reclamation of moss peat and other infertile types. Probably the most satisfactory early schemes of reclamation of such peats were developed in this country, and were undertaken practically without scientific data and without much record having been kept of the operations. The general method adopted was to remove practically the whole of the peat for fuel, and replace the turf on the surface where it might be burnt or ploughed in. Lime was applied as well as dung or refuse of any kind. Where more than a foot of peat was left, sand, clay, or mineral soil was worked into the peaty plough layer. In quite early times the sowing of clover was advocated as a means of enriching the peat soil. These are the bones of the scheme described by Roy Hay in the article in *Agriculture* in October, 1947—"A German Peat Bog Reclaimed".

Some of the schemes were given a good press, to use a modern expression ; but these were not necessarily the best, nor were they the most generally adopted. With the decline in the value of agricultural land in Britain most of these practices ceased and the memory of them is largely lost. During the last century land hunger on the Continent has been growing, and the amount of land desired has exceeded that which could be made available by skinning peat as described above.

There have come into favour over most of the Continental countries methods of reclamation similar to those adopted in earlier times for the fen peat lands, in which the peat itself forms the soil. Although the methods advocated are quite successful in the sense that such peat can be made to produce good crops and, with modern scientific knowledge, can be maintained at a high level of production, it seems to me that the cost of reclamation and the specialized art of maintaining reclaimed moss peats are not likely to compare favourably with the cost of maintaining marginal land and of reclaiming and maintaining the large areas of waste mineral soil which still exist in this country. It is thus felt that the reclamation of peat moss should be a secondary consideration until the available mineral soil is brought to reasonably full production.

The type of reclamation described in Roy Hay's article is an entirely different matter. Below much of our peat lands there is quite good soil, for example in river valleys, on sands and on much of the low-lying drift deposits. If the peat is removed from these, either by large-scale operations or by local efforts to supplement fuel supplies, the reclamation required is similar to that required for ordinary waste land, although special drainage problems may have to be faced. If the underlying soil consists (as it may often do in upland country) of very bouldery morainic drift, then, in spite of the improved methods which may arise from the use of modern machinery, it is unlikely that the ground can be made use of for agriculture as economically as it can for afforestation, any more than can similar waste land.

The reclamation of peat land in this way is, in its simplest terms, no more than the application of modern knowledge to the practice by which very large areas (e.g., in the north-east of Scotland) were reclaimed in the nineteenth century; and this practice, both here and on the Continent, was formulated mainly on the experience gained in the "improvement" of cut-over peat land in Britain.

FRUIT AND VEGETABLE STORAGE

REPORT OF CONFERENCE HELD AT SITTINGBOURNE ON MARCH 3, 1948

W. G. KENT, N.D.H.

National Agricultural Advisory Service, South-Eastern Province

DR. FRANKLIN KIDD, Director of Food Investigation, Department of Scientific and Industrial Research, presided at a Conference of fruit growers and cold storage engineers at Sittingbourne on March 3. Sir Edward Appleton, Secretary of the Department of Scientific and Industrial Research, who opened the Conference, said that thirty years of collaborative research work by Dr. Kidd and Dr. West of Ditton Laboratory, had placed this country in the forefront as regards the storage of fruit and vegetables. The work had started in a manner traditional to this country, as a study of an academic problem, but had resulted in Britain leading the world in this particular branch of applied science.

Sir Edward pointed out that the "gas" in the term "refrigerated gas storage" was not that used in heating and lighting, but was the one normally breathed out by all living plants and animals—namely, carbon dioxide. Control of temperature and of the proportion of carbon dioxide and oxygen in the storage chamber enabled certain fruits and vegetables to be stored in a fresh condition for very long periods.

Gas Storage of Pears Dealing with the gas storage of pears, Dr. West said that results of six years' work before the war were reported in a paper in the *Journal of Pomology*, March, 1942. It was hoped that a Food Investigation Board leaflet on the matter would be available shortly. Unlike apples, pears for gas storage should not be wrapped, since they are not susceptible to the superficial scald so troublesome with apples, and the oil of the wraps is liable to cause local browning of the skin of the fruit. Pears, too, are more resistant than apples to low temperature injury; and temperatures as low as 32° F. can be used. Fruit should be picked in the hard, green condition. If picked too early it usually fails to reach the best dessert quality, and if picked too late it is impossible to attain the correct storage condition before the critical point is reached. Dr. West emphasized the importance of getting the fruit into store and establishing correct temperature and atmospheric conditions within 4–5 days of picking. In cold storage (ordinary air) Conference pears could

be kept up to about 3½ months at 34° F. with a humidity of 90 per cent saturation.

Refrigerated gas storage at 32° F. enabled Conference pears to be kept some 6 or 7 months in conditions of restricted control ventilation—that is, in the way Bramley's Seedling apples are kept, without the use of a "scrubber". The use of a scrubber, which permits an atmosphere of 5 per cent carbon dioxide and 2.5 per cent oxygen, extends the storage period for another two months. Doyenné du Comice pears can be kept in cold storage at 32° F. for about 4½ months, and rather longer in a scrubber-controlled atmosphere containing 10 per cent carbon dioxide and 2½ per cent oxygen. Williams' Bon Chrêtien pears keep in cold storage at 32° F. for 7–8 weeks, but in gas storage, in an atmosphere of 10 per cent oxygen and 10 per cent carbon dioxide, they keep for 5–6 months, and a scrubber is not required.

With all pears it is necessary to complete the ripening of the fruit at a temperature of about 60° F. in order that suitable dessert quality may be developed, occurring in 12 to 16 days at that temperature after removal from store. The time taken for fruit to ripen after removal from store is much the same at the end of the storage season as it is in the earlier part of the season.

Apple and Pear Scald Dr. J. C. Fidler spoke on research in connection with apple and pear scald. Not all varieties of apple are susceptible to this form of injury, which is caused by volatile substances given off from the apples themselves. Scald is rare with Cox and Worcester, but Edward VII, Lane's Prince Albert, and Bramley's Seedling were intermediate, and Newton Wonder very susceptible. He emphasized that though a good deal of scald might reveal itself later in the storage life of the fruit, it was the first three to six weeks' storage in which the damage actually occurs. The composition of the storage atmosphere must, therefore, be watched carefully at this period. Precaution against scald consists of wrapping each apple closely in a thin tissue paper impregnated with an odourless and tasteless mineral oil forming about 15 per cent of the weight of the paper. The wrapping is not effective if loose.

Dr. Fidler suggested that methods of counteracting scald involving less labour than wrapping, at a time when it was highly desirable to get the apples into store quickly, might be possible in the future. It is not desirable to lower the optimum carbon dioxide content of the atmosphere to counteract scald.

Pear scald is entirely different and not due to the emanation of volatiles from the fruit, so that oiled paper wraps are not used for pears. Mechanical injury to the skin of the ripening pear after storage is very easy and may resemble scald externally.

Skin Coating Dr. A. C. Hulme spoke of investigations into skin-coating treatment, as, for instance, when apples are dipped in an oil emulsion or sprayed with a thin coating of oil. It was emphasized that the results so secured are not as good as those with gas storage, but Cox's Orange Pippin apples, for example, dipped in an oil emulsion and stored at 40° F. have been kept in commercial condition until the end of February. Skin-coating prevents loss of weight and shrivelling due to evaporation of moisture and extends the storage life of the fruit by 4 to 6 weeks. The commercial application of skin coatings to fruit is being examined, and it was predicted that machines to spray every apple individually with a thin coating of liquid may be used in the future, since some fruit, especially when immature, is susceptible to damage by over-dipping, which results

in an unpleasant, alcoholic flavour. Where the loss in weight during storage of a bushel of apples has been 5½ lb., it was reduced to 3 lb. if coated before storage, and a brighter sample resulted. Costs in a 50-ton trial worked out at 3½d. per bushel, discounting depreciation of plant.

Plums Mr. W. H. Smith dealt with work on the storage of plums. Plums should be picked with stalks, firm-ripe and well coloured. Fruits of Victoria stored at 34° F. in air (i.e., in cold storage) had a maximum storage life of three weeks, but they must be ripened off in a temperature of over 50° F., preferably about 60° F. At 31° F. internal browning was caused. It is an interesting fact that two days at 60° F. after 15 to 20 days at 34° F. and a quick return to 34° F., enables fruit to be kept for a further 2 to 3 weeks and for final ripening at 60°–65° F. The practical problem of quickly warming plums from 34° F. to 60° F. and equally quickly re-cooling to 34° F. had not, however, been solved. A leaflet on plum storage has been published by the Food Investigation Board.*

Vegetable Storage Potato storage was discussed by Mr. H. Wager, who stated that the disadvantages of potato clamps were :

(1) Difficulty in deciding correct thickness of cover in autumn, owing to uncertainty of winter temperatures.
(2) Insufficiently cool in spring.
(3) Often too dry or too wet.
(4) Can only be opened in non-frosty weather.
(5) Appreciable cost of making and clearing.
(6) Loss of weight and condition of potatoes after March.

In America, he said, special potato storage houses which can be heated to prevent frost injury are used. They are long, narrow buildings with insulated walls and roof, and a long central alleyway through which lorries can be driven. Preparing potatoes for dispatch is then a bad weather job instead of one confined to non-frosty days.

Certain chemicals are available to prevent rotting due to diseases and others to inhibit sprouting, but the times and methods of practical commercial application to the tubers need further investigation.

Correction

A Method of Nutrient Application for Soilless Culture. A. Rhodes, B.Sc., Ph.D. (April, 1948) : "vermicunite" should read "vermiculite".

* *Cold Storage of English Plums,* Food Investigation Leaflet No. 1, obtainable from Lloyds Bank Chambers, Hobson Street, Cambridge.

SUMMER POTATO STORAGE IN CLAMP AND COOL STORE

C. R. FURLONG, B.Sc., A.R.C.S.
Ditton Laboratory, East Malling, Kent

SOME trials were carried out in 1943 as part of the programme of the Food Investigation Board of the Department of Scientific and Industrial Research, to determine the effect of cool storage at 40°–42°F. for several months on 1942 maincrop potatoes following their removal from the clamp in the spring. One of the stores used for these trials was situated at the East Malling Research Station, and the potatoes in this store were taken from a clamp at this Station. Part of the clamp was left intact after the store was loaded, and parallel observations were made on the clamp and the store throughout the period of the trial. In addition, one chamber of the store was held at 45°F. instead of 40°–42°F., and a low concentration of ethylene was maintained in the air to determine whether sprouting could be inhibited at a temperature at which sweetening was not likely to occur.

The results obtained are recorded below. On such aspects as loss of weight and the effect of the height of the stack, the data have been supplemented by data obtained at several commercial stores.

Details of the Experiments The clamp contained initially 100 tons of Majestic potatoes, grown on a medium heavy clay loam. It was sited north and south and covered in the orthodox manner with a good layer of straw and soil. The southern end was reserved for observation, and thermometers were installed at the top, middle and bottom respectively and as centrally as possible. Continuous recordings were obtained for the top and bottom positions. Immediately after the removal of potatoes to store, the exposed end of the clamp was re-covered with a good layer of soil.

The two chambers of the stores used for the experiments, one at 40°–42°F. the other at 45°F., were designed for the gas storage of apples. The doors were left unsealed to allow slight ventilation so that the concentration of CO_2 did not rise above 0.2 per cent throughout the storage period. The average temperatures during the storage period were 40.2°F. and 44.9°F. respectively.

Eighteen tons of potatoes were placed in each store. The loading of the store held at 40°–42°F. took place over the period April 22 to 28, and that of the store at 45°F. over the period April 28 to May 6.

The potatoes were riddled and the sprouts removed before they were put in new 1-cwt. sacks, which were placed in the store within a few hours of removal from the clamp. The sacks were built into stacks, each in layers of three, two side by side, and the third transversely at opposite ends in alternate layers. Stacks were built to a height of four, six and eight sacks to determine the effect of the different loads on the bottom potatoes. A gap of 6 to 9 inches was left between the stacks and the walls of the store, and a gap of 3 inches between the stacks.

After the chamber held at 45°F. was loaded and closed, a measured quantity of ethylene was passed in through a pipe in the wall. A concentration of 1 part in 10,000 was aimed at, as this had been found to retard sprouting successfully*. Owing to the need for slight ventilation to prevent accumulation of CO_2, it was not possible to maintain a constant concentration of ethylene. Sufficient ethylene to give a concentration of 1 part in 5,000, based on the total volume of the chamber was, therefore, passed in every third or fourth day.

---

* *Ann. Rep. Food Invest. Bd., Lond.* (1932), p. 51.

Control samples of potatoes for this experiment were stored in air at 45°F. at the Ditton Laboratory.

Conditions in the Clamp from April to August: SPROUTING AND WASTAGE At the end of April, when the potatoes were taken from the clamp for further storage, 1.5 per cent of rotting was present and about 6.5 per cent of the tubers were found to be mechanically damaged. The percentage by weight of sprouts was 1.9; the tubers were firm. Sprouting had increased to 5 per cent by weight by the end of May and to 12.1 per cent by the end of June, when the tubers were severely wilted. By the middle of July new tubers had begun to develop and the total weight of sprouts plus new tubers was 20 per cent. At the end of August the clamp was collapsing, the old tubers were severely shrivelled and there was a large crop of new tubers. Rotting did not develop appreciably during the trial.

COOKING QUALITY In April the potatoes when boiled were floury in texture with a good flavour and colour. At the end of May the texture and colour were good, but the flavour had deteriorated to some extent. At the end of June the flavour was only fair and the texture was less floury; the colour, however, remained good.

TEMPERATURE The average weekly temperatures recorded for the last week of April were 54.9°F. at the top of the clamp, and 52.7°F. at the bottom. The air temperature was 51.1°F. After the first week of May, when the average weekly air temperature had risen to 55.5°F., the temperatures rose steadily and in the first week of June 68.4°F. was

Table 1. Average Weekly Temperature (degrees F.) from April to September at Three Positions in the Clamp

WEEK COMMENCING	TEMPERATURE (*Degrees F.*)			
	Top	Middle	Bottom	AIR*
25.4.43	54.9	—	52.7	51.1
2.5.43	55.1	53.3	52.5	49.4
9.5.43	56.4	54.9	53.3	55.5
16.5.43	62.7	60.9	56.9	55.6
23.5.43	68.2	65.7	60.5	58.5
30.5.43	69.8	—	62.3	56.6
6.6.43	68.4	67.8	62.3	60.0
13.6.43	68.4	67.3	62.7	56.2
20.6.43	68.9	68.0	63.3	60.3
27.6.43	69.8	68.8	64.1	60.5
4.7.43	76.2	71.6	67.1	58.2
11.7.43	76.5	—	68.0	61.5
18.7.43	77.0	—	68.9	60.6
25.7.43	83.3	—	73.4	67.0
1.8.43	86.0	—	75.2	63.5
8.8.43	83.3	—	76.1	62.0
15.8.43	84.2	—	76.1	63.8
22.8.43	86.0	—	77.0	58.8
29.8.43	82.4	—	77.0	60.5

* The average weekly temperature is derived from the maximum and minimum day temperatures.

recorded at the top of the clamp, and 62.3°F. at the bottom. The temperatures remained fairly steady at these levels throughout June, and the air temperature also remained fairly steady at about 60°F. Temperatures again rose steadily throughout July and August, reaching a maximum in the week commencing August 22, when 86°F. was recorded at the top, and 77°F. at the bottom. The maximum average weekly air temperature recorded was 67°F. for the last week of July; during the first half of August it remained high at between 62° and 64°F. and then started to fall (Table 1). The central position was intermediate in temperature between the top and bottom positions.

Condition of Potatoes during Storage at 40°–42°F. Samples of the potatoes in the 40°–42°F. chamber were examined 30, 65 and, finally, 129 days after the completion of loading on April 28. Their condition at each examination is shown in Table 2.

Table 2. Condition of Majestic Potatoes at Intervals during Storage at 40°–42°F.

Days in Store	Percentage by Weight		Cooking Quality	Remarks
	Rotting	Sprouting		
30	—	very slight	Floury, good flavour and colour	Slight wilting; sprouts of $\frac{1}{16}$ inch on 30 per cent of tubers
65	—	slight	Fairly floury, good flavour and colour	Slight wilting; sprouts of $\frac{1}{8}$ inch on 53 per cent of tubers
129	2.8 (Dry rot)	slight approx. 0.2	Fairly firm mealy texture, good colour and flavour but slightly sweet	Moderately wilted; sprouts (up to 1 inch) on 21 per cent of tubers

The samples examined at the end of May, 30 days after the closing of the store, were in excellent condition, sprouting was very slight and the tubers when boiled were floury and of good flavour and colour.

Early in July, after 65 days' storage, sprouting was slight and the tubers were slightly wilted. The flavour and colour were good, the texture appeared to be rather less floury than it was initially. On the whole the sample was a little superior in flavour to that drawn from the clamp at about the same time.

When finally withdrawn from the store at the beginning of September after 129 days of storage, the tubers when cooked were still of good flavour and colour, but slightly sweet; the texture was firmer but less floury than it was initially. The percentage by weight of sprouts was not more than 0.2 per cent; 2.8 per cent of Dry Rot was present.

Loss in Weight during Storage The average loss in weight in the stores where the sacks were stacked to an average height of 6 sacks and air circulation was continuous was about 9 per cent after 120 days. The loss for shorter periods of storage was

less in proportion approximately to the length of the period. In one store the refrigerating machinery was run and the air circulated only when the temperature rose to 42°F., and it was stopped when the store had been cooled to 40°F. This store was also loaded to its full capacity. The loss in weight here was only about 3 per cent after about 100 days' storage.

Effect of Height of Stack The results for the effect of the height of the stack on the bottom potatoes were:

Number of layers in the stack	4	6	8	12
Percentage by weight with pressure marks	15.5	17.5	22.0	26.3

Pressure marks (flattening with an impression of the sack) and depressions at the points of contact of tubers, etc., were not very noticeable on the potatoes at the bottom of the stacks of four and six layers. They were more obvious in the case of the higher stacks, but even in the highest they were not so severe as appreciably to affect the commercial value of the potatoes. No crushed, and very few split, tubers were observed.

Effect of Ethylene on Sprouting at 45°F. The presence of ethylene in the air at a concentration of about 1 part in 10,000 almost completely inhibited sprouting. The sprouting of the ethylene-treated potatoes is compared in Table 3 with that of potatoes in the compartment held at 40°–42°F. and also with that of the control samples held at 45°F. in air at the Ditton Laboratory. The cooking quality of the potatoes treated with ethylene was as good as that of those stored at 40°–42°F. There was no appreciable sweetness

Table 3. Effect of Ethylene (1 in 10,000) on the Sprouting of Potatoes at 45 F.

Treatment	Percentage weight of sprouted tubers	Maximum length of sprouts	Percentage by weight of sprouts
45°F. (with ethylene)	2.8	1/16 in	trace
45°F (air control)	100.0	6 in	2—3
40°–42°F (air control)	21.2	1 in	0.2

Cost of Cool Storage and of Ethylene Treatment It is not within the scope of this article to discuss the economics of storage in the clamp as against cool storage It is of interest, however, to record the costs for storage and for the ethylene treatment.

The cool storage charges were 10s. per ton for the first week (including loading and unloading) and 2s. 6d. per ton per week subsequently.*

Approximately 2 cu. feet of ethylene were used per week at a cost of 3d. per cu. foot, the store having a capacity of 4,000 5,000 cu. feet. The quantity of potatoes stored in this instance was 18 tons.

Summary The observations on the clamp showed that at the end of April the average temperature inside the clamp was about 2.7°F. higher than that of the outside air. In May the temperature began to rise more rapidly than the air temperature, so that in early August, when the average temperature of the clamp had reached a maximum of about 80°F., the difference was 18°F.

Heavy sprouting had occurred by the end of May; the tubers were wilted and the flavour was deteriorating. By the end of June wilting and sprouting were so advanced that the potatoes were almost useless.

---

* These costs were fixed on the advice of the Cold Storage Division of the Ministry of Food.

In contrast with the clamped potatoes, those in store at 40°–42°F. were still in very good condition at the end of June. At the end of August the texture and flavour were still fairly good. There was slight sweetening, but sprouting was not serious.

Storage at 45°F. in air containing a low concentration of ethylene (1 part in 10,000) almost completely inhibited sprouting. The treatment had no adverse effect on quality.

Loss in weight of the potatoes after 120 days' storage was about 9 per cent in the stores in which air was circulated continuously ; in a store which was fully loaded, and in which air circulation was intermittent, the loss was only about 3 per cent for approximately the same period of storage.

The bruising and marking of potatoes in the bottom sacks was not very serious, even when the stacks were 12 sacks high.

FARMING AFFAIRS

Taking the Food to the People A conversation I had two years ago in China with Dr. T. H. Shen, an agriculturist at the agricultural experiment station outside Peiping, illustrates one method of attacking food problems.

In the course of investigating Chinese post-war food problems, I asked Dr. Shen whether, in a country as large as China proper (south of the Great Wall and excluding Inner and Outer Mongolia and Tibet), there is ever a year when crops do not fail in some area.

Dr. Shen answered that somewhere in China there are crop failures of varying degree every year, and I asked how, in view of insufficient communication, transportation, and other facilities, China could move enough food to prevent starvation in these areas.

Dr. Shen replied : "The people migrate to the food."

He then showed me a map of the historic routes that migrants have taken in China when food shortages or famines occur in the various producing areas. The map showed that when famine strikes in Honan Province some of the people go to Shensi, others to Shantung, some to Hupeh, and some all the way to Szechwan. Similarly, when famine strikes in Hunan Province, some of the people migrate to Hupeh Province, some to Kwangsi, some to Kweichow, and others to Kiangsi.

This Chinese response to a very difficult problem would hardly be usable in the world as a whole. We have to take the food to the people.

The tremendous change from pre-war years to the present in the international movement of a group of most important famine-fighting foods—the grains, including rice, and soya bean—illustrates the enormous effort which the U.S.A. and Canada, among other countries, have been called upon to make to meet the food crisis. Before the war the main flow of international trade in grain and soya beans was from South America to Europe. In 1946-47 the source of the predominant flow of trade in these foodstuffs had shifted to North America.

If the changes in world movement of these important commodities persist, they hold highly significant implications for the agriculture of the world.

During the period of hostilities in both World Wars I and II, we had a world shortage of food. But food production recovered quickly after World War I, and in a short time there were actually food surpluses, particularly of grains, that eventually became burdensome in many countries.

Probably most agricultural economists expected a similar development after World War II. To date no such condition is even in sight. The current outlook is for a world shortage of food, particularly of cereals, for some years to come. The situation is much too complicated to come under the generalization contained in the usual broad statement—"It's because of the war". The total world production of grains and soya bean in 1947 was estimated at 564 million long tons, compared with 597 million before the war, the heavy decreases occurring mainly in the western European countries and the Far East.—COL. R. L. HARRISON, *Special Assistant to the Secretary of the U.S. Department of Agriculture on World Food Problems, writing in "Foreign Agriculture", March,* 1948.

Kale Folding The present aim of the dairy farmer is self-sufficiency, especially as far as protein is concerned. Grass supplies all he needs for cattle and sheep in summer. Kale is its nearest approach for use in winter. It is superior to root crops, since it costs less to grow, is cheaper to feed, and gives a very high yield of starch and protein equivalent per acre. As an aid to both quantity and quality of winter milk, kale has no equal.

The drawback to kale has been the feeding of the crop, for cutting and carting can be very trying in bad weather, and the cost about equals that of growing it. On fairly light, well-drained soils the ideal system for both large and small farmers is folding by the electric fence. In this way the labour costs of feeding are reduced to a minimum. This practice cannot, of course, be recommended on farms where the cattle are customarily housed throughout the winter, except perhaps for about a month in late autumn, when the grass has gone off and before severe weather has set in.

The acreage allotted to kale will vary greatly from farm to farm ; about one-tenth acre per cow, given a good yield, is sufficient when fed at the rate of 56 lb. per head, to last from September to Christmas. Often kale can be folded nearly all the winter, and then three-tenths acre per cow (and her followers) is not too much. Where a large acreage of kale is to be grown it would be an advantage to make two or three sowings ; the last week in March or first fortnight in April for maximum autumn yield. A crop of marrowstem kale sown at this time would be ideal for folding from mid-September onwards. Thousandhead kale could be drilled in June, following an early silage crop and this would be ready for the latter half of the winter.

As cleaning or fallow crops the kales are extremely useful ; provided sufficient attention is given to cleaning in the early stages, the subsequent profusion of foliage will effectively suppress any further weed growth. By cutting out hand cultivations entirely, the cost of growing kale can be kept down to about £10 per acre.

Kale folding has been carried out successfully in Berkshire, Gloucestershire and elsewhere, and it seems that here is a logical method of winter feeding combining cheapness with ease of working. Obviously it is not applicable to all parts of the country, but in areas where conditions permit,

this system offers attractive possibilities to the commercial dairy farmer and may go a long way towards reducing the costs of winter milk production.

R. A. JOHN, *Department of Agriculture, University of Reading.*

Story of the Milk Marketing Board In September, 1929, milk producers on some of the outlying farms in North Yorkshire were summoned to the office of the firm which they had been accustomed to supply. No contracts had yet been made and the zero hour of October 1 loomed close.

"Gentlemen," said one of the Directors, after a somewhat embarrassed greeting, "we will buy your milk as usual from October, but the uncertainty of the manufacturing market compels us to impose two conditions: the price will be 4½d. per gallon, and . . ." he paused slightly because of some apparent diffidence in making known his final condition, "it must be delivered free of cost to our dairy."

In that part of Yorkshire, and indeed in many other places as well, a daily average of two gallons of milk per cow is as much as can be expected, so at 4d. per gallon on the farm, these dumbfounded producers, after a simple mental calculation, estimated their daily return at 8d. per cow. Thus to feed, house and milk a dozen cows—which is slightly above the average number maintained by half of England's milk producers—would bring them in a gross weekly cheque of £2 16s. 0d.

The situation today is vastly different. The Milk Marketing Board, which ranks as one of the largest cooperative organizations in the country, was set up under the Agricultural Marketing Acts of 1931 and 1933 by the milk producers of England and Wales to eliminate the speculative character of milk production. The story of the Board's inception and lusty growth is told by Mr. R. A. Pepperall in a new publication*, which everyone concerned with the industry will want to read. Up to September, 1947, the total value of milk sold by producers reached £1,156 million. In the first year of its life the Board marketed 856 million gallons; in 1945-46 the figure was 1,259 million gallons. With an assured market and a guaranteed price, modern milk producers, unlike the dairy farmers in the 1920s, can plan ahead with confidence to give the public its daily milk without restriction.

How Many Spiders to the Acre? How many spiders are there in, say, an acre of grassland? Of course the numbers will vary in different fields and at different seasons, but the correct answer is so unexpected to most people that I have been tempted to try out an adapted version of a schoolboy trick on anybody who is willing to play. Think of a number (the player must give his honest guess as to the spider population of an acre of grassland). Double it. Multiply by a thousand. What is the answer? I sometimes find the answer is about right, and in cases where it is excessive the guesser is often imagining an acre to be larger than it really is! A census in a Sussex field of rough grass showed a maximum spider population in late summer slightly in excess of 2¼ millions to the acre.

Numbers of this magnitude are difficult to grasp. If the 2¼ million spiders from this acre of land were to combine in building one continuous thread, the resultant thread after about one day's spinning would just about go round the world at the equator. In ten days' spinning the thread would reach to the moon!

* *The Milk Marketing Board*, price 4*s*. 6*d*. (by post), direct from the Librarian, Milk Marketing Board, Thames Ditton, Surrey.

The spider population of England and Wales can, of course, only be guessed at. My guess is an average of 2⅕ billions. At a very conservative estimate each spider destroys insects at the rate of a hundred per annum, so we arrive at a yearly insect consumption in England and Wales of 220,000,000,000,000 (two hundred and twenty billions).

Retreating, dizzy but undaunted, to an illustration we can all understand, let us say that the weight of insects destroyed by spiders in England and Wales each year well exceeds the weight of human beings in these countries ! Let me also say quite definitely that spiders eat many times the number of insects consumed by birds . . . Birds get a good reputation, partly because people like them. Spiders have a bad reputation because people either actively dislike them or fail to realize the huge part they play in insect destruction.

The above is an extract from Dr. W. S. Bristowe's interesting and most readable essay, *Spiders*, a King Penguin book published at 2s. 6d.

All too often spiders are killed merely because of personal dislike—a fact which in all probability has its roots in an unconscious, ignorant fear that has not yet been bred out. Most of the old superstitions have gone, although a few are still respected in some places ; but prejudice and fallacy remain nearly everywhere. The "man in the field," equally with his urban counterpart, has little knowledge of the beneficent part that spiders play in the balance of nature. Dr. Bristowe's book is a remedy immediately to hand.

The Agriculture Act Explained The Agriculture Act, 1947, is undoubtedly one of the most important pieces of agricultural legislation which has been placed on the Statute Book at any time. Because of its wide scope it is unavoidably long, and some of its provisions make somewhat complicated reading. A recently published handbook* by Mr. J. Muir Watt, M.A., which explains its 111 Sections and 13 Schedules, will therefore be welcomed by the ordinary farmer, and perhaps by land agents and agricultural valuers as well.

Mr. Watt is a barrister and Joint Assistant Secretary to the Chartered Auctioneers' and Estate Agents' Institute. The Act itself is not included in this guide, but parts are quoted in full where necessary and references are given throughout to the relevant Sections and Schedules. Examples are given to illustrate the workings of many Sections, and the underlying reasons for the provisions of the Act are well brought out.

FOUL BROOD DISEASE OF BEES ORDER, 1942

SUMMARY REPORT, 1946-47

THE returns furnished by County Agricultural Executive Committees on the application of the Order in 1946 and 1947 show an increase in the number of apiaries and colonies of bees inspected by Appointed Officers since 1944, when complete returns were first available. The figures have risen from 6,600 apiaries visited and 26,500 colonies examined in 1944, to 12,400 apiaries visited and 52,000 colonies examined in 1947. This means that during last year alone, over one-tenth of the colonies of bees

* *Current Law Guide No.* 1. Sweet and Maxwell 6*s.* 6*d.*

in England and Wales were officially examined for Foul Brood. Figures for each of the last four years, together with the number of cases of Foul Brood discovered during the course of the inspections, are given in the following table:

	1944	1945	1946	1947
Apiaries visited	6,600	9,300	10,900	12,400
Apiaries in which Foul Brood was found	1,015	941	819	888
(American F.B.) ..	995	930	795	845
(European F.B.) ..	20	11	24	43
Colonies examined	26,500	35,200	45,200	52,000
Colonies in which Foul Brood was found	1,845	1,632	1,409	1,506
(American F.B.) ..	1,802	1,602	1,357	1,361
(European F.B.) ..	43	30	52	145
Percentage of infected apiaries	15.4	10.1	7.5	7.2
Percentage of infected colonies ..	6.9	4.6	3.1	2.9

Cases of Foul Brood discovered under the Order are subject to a notice served upon the owner requiring him, within a specified period, to destroy the bees and combs in the infected hive(s) and to decontaminate the hives.

It will be seen that although the search for Foul Brood has been steadily intensified since 1944, the incidence of infected apiaries and infected colonies per hundred inspected has declined from 15.4 to 7.2 and from 6.9 to 2.9 respectively, taking the figures for England and Wales as a whole. In individual counties where the need for disease control was known to be most pressing, owing particularly to the widespread incidence of American Foul Brood, excellent work has been done by County Committees and their Appointed Officers in maintaining a high level of inspections over several years, and it is in these areas that a real decline in the incidence of disease can be spoken of with some confidence. In some counties, however, a more intensive search of surrounding apiaries when individual cases of disease are discovered, might well reveal a higher incidence of Foul Brood than the available figures indicate.

Effect of E.F.B. Outbreaks in Wiltshire

The actual number of cases of Foul Brood discovered was higher in 1947 than in the previous year. This increase is largely accounted for by the cases of European Foul Brood found as a result of the inspection of a series of apiaries maintained by a commercial beekeeper in Wiltshire. The outbreak was first discovered in 1946, but not before a large number of colonies of bees had been sold from these apiaries to beekeepers in many parts of England and Wales, and in Scotland. The seller immediately stopped further sales, notified all his customers of the outbreak and supplied a list of his sales to the Ministry. Agricultural Executive Committees in the counties concerned were asked to arrange for an inspection of all apiaries to which bees from this source had been delivered, and these inspections brought to light 36 of the 52 cases of European Foul Brood recorded in 1946.

In 1947 the surviving colonies supplied from this source in 1946 were again examined, as were also all the colonies in the apiaries where the outbreak originated. This latter series of inspections involved 510 colonies, among which 87 cases of European Foul Brood were found. Standstill and destruction notices were issued in the usual way. Later in the season the owner voluntarily destroyed all the bees remaining in these apiaries to eliminate any potential sources of further infection. No bees from the apiaries concerned were sold or moved to other sites in 1947, the owner's present stocks of bees having been built up from other sources which have had no contact with the bees or apiary sites concerned in the outbreak.

Among the bees sold by him in 1946, European Foul Brood was confirmed in sample combs submitted by Appointed Officers from 41 colonies. Thus 128 of the 145 cases of European Foul Brood disease recorded in 1947 were attributable to this outbreak in Wiltshire.

Sulphonamide Treatment Further experience with the sulphonamide treatment of American Foul Brood* has been gained as a result of another series of trials carried out in 1947. The treated colonies will be kept under observation in 1948. A report on the progress of the trials was discussed at a recent meeting of the Bee Disease Advisory Committee. The Committee considered that there would be no justification in recommending the sulphonamide treatment as a safe and practical alternative to the destruction of colonies infected with American Foul Brood discovered under the Order, and this view has been accepted by the Ministry.

Encouraging progress in the reduction of the incidence of Foul Brood has been achieved as a result of the powers given to County Committees under the Order, and all Committees and their Appointed Officers are urged to continue the search for disease with undiminished energy. Further reduction in the incidence of Foul Brood can be achieved only by continued vigilance and the prompt cleaning up of areas where disease is still to be found. Beekeepers are again asked to continue their cooperation by giving Appointed Officers every facility in carrying out their work of locating outstanding centres of infection.

BOOK REVIEWS

Report of the Potato Storage Mission to the United States and Canada.
AGRICULTURAL RESEARCH COUNCIL. H.M. Stationery Office. 1*s*. 3*d*. (1*s*. 5*d*. by post)

This report is a useful addition to the growing list on North American agriculture. Until the potato stores are seen in Maine and in New Brunswick, the relatively happy conditions under which the crop is harvested in Britain are not fully appreciated. The fact that we can lift and store in the open field gives us a considerable advantage. Even with that advantage, however, the bad conditions which often prevail both at lifting and dressing have led many progressive farmers to think in terms of potato houses, where the crop can be housed and dressed.

In our humid climate the advantages of insulation of all farm buildings is not sufficiently appreciated. Even in the housing of animals we are apt to erect buildings without hollow cavities, and now, with shortage of materials, the roofs are too light to equalize the temperatures. With such a sweating crop as potatoes it is very important that the excess moisture should be led away rapidly from the stored crop. Those who have used uninsulated potato houses know how necessary it is to cover the crop with a deep layer of straw to absorb the moisture. Every step must be taken to combat stagnant damp air. In the U.S.A. and Canada, it is sometimes found necessary to have forced circulation of air. The case is analagous to that of the greenhouse operator who may keep heat in the pipes just to circulate the air.

Quite obviously the mission has done a good job in collecting all the material for the information of home growers. There is an increasing need for study of labour conditions to remove drudgery and to increase efficiency. The programme of investigation suggested by the reporters is sound and when completed should be most useful. Even although there is at present little likelihood of new building material being available there is always the possibility of converting old buildings. In any case it is safe to assert that potato houses are bound to increase in number, and this report provides a very good picture of prevailing practice where they are used.

T.B.M.

* See *Agriculture* (May, 1947), 54, 82.

BOOK REVIEWS

Barley. Fifty years of Observation and Experiment. E. S. Beaven. Duckworth. 30s.

The Preface to this work was written by Dr. Beaven and it is not quite clear to the reader that the book in its final form was prepared for publication some years after his death, which took place in 1941. A great debt of gratitude is due to Miss N. Stallwood, whose association with Dr. Beaven in his later years made her conversant with the details of his many investigations ; to anyone else the magnitude of this task would have been almost insuperable.

It is always inspiring to study at first hand the notes made by one who is a master of his subject, and it is from this point of view that the book is of great interest. The field and laboratory notes and the mental speculations of this great authority form a classic record covering at least fifty years of actual work in his particular sphere of research. Papers covering such a range of time must inevitably contain points of view reached at different stages of development. As Lord Bledisloe explains in the Foreword, it was the hope of the author that his grandson would maintain the great traditions of Warminster, adapting to modern conditions the work so ably conducted there. This was not to be, for unhappily Beaven Wood, the brilliant son of the late Professor T. B. Wood, was killed in Normandy in the summer of 1944, two years after the death of Dr. Beaven.

The book is divided into two parts, Observation and Experiment. The first part presents the conclusions of an authority who certainly cannot be accused of pedantry. The views expressed by the author are stimulating and provocative, though their value is sometimes diminished because they do not include references to recent publications by other workers. For example, the author urges the necessity of continued selection in seed stocks if commercial uniformity is to be maintained. It is gratifying to find the full text of the author's valuable paper " Varieties of Barley " included in the book. Unfortunately the photographs which appear there are insufficient to enable identification of most present-day varieties to be made on the external characters of the grain ; in this connection the reader, and especially the student, would benefit by reference to G.D.H. Bell's descriptions contained in his paper " Classification and Identification of Two-row Barleys," published in 1937.

Part 2 entitled " Experiment " deals mainly with field records obtained in the course of actual breeding work, though a most interesting analysis of the classic results obtained in the growing of barley at Rothamsted during the past century under carefully controlled conditions is also included.

Dr. Beaven fought a relentless battle against the use of eye judgment as a substitute for accurate yield trials. The half-drill strip method of measuring yields, which is associated with his name, has proved invaluable when comparing two varieties. Although modern statistical theory indicates that a more randomized arrangement of trial plots is preferable, Dr. Beaven conferred an immense benefit on crop testing work by drawing attention to the dangers of basing conclusions on results from weighing single plots. Although his main work was done before combine drills were introduced into this country, Dr. Beaven prepared the way for this practice by emphasizing the importance of an adequate supply of soluble phosphates and nitrogen during the early stages of the plant's development.

Those in the habit of sowing barley in the autumn will note with interest the author's comment that Spratt-Archer and Plumage-Archer are not winter hardy in the accepted sense. As a plant breeder he opposed the introduction of large numbers of new varieties and helped to develop the position in which about three-quarters of the English barley acreage was sown with his own variety, Plumage-Archer and Dr. Hunter's Spratt-Archer. Although it would have been easy for Dr. Beaven to have condemned the use of combine harvesters, he maintained the constructive attitude that better work could be done in both good and bad weather with these machines than with a binder provided the newer machine was used properly. On the other hand, he recognized that all mechanical means of harvesting barley tend to check maturation and so to give less mellow samples than were previously obtained by hand labour.

The book is an inspiring record of a successful attempt to solve an agricultural problem. Many new questions are raised, and many old ones receive a new orientation. It is hoped that when this book is reprinted a larger index will be supplied, so as to make the various records more readily accessible to what will undoubtedly be a large circle of readers.

F.R.H.

Wild Animals and the Land. F. HOWARD LANCUM. Crosby Lockwood. 10*s*. 6*d*.

In the first sentence of the introduction to his latest book Mr. Lancum indicates that here is an attempt to assess the character of the wild animals found in this country and to place them in their rightful position *vis-à-vis* the man on the land.

In these days, when maximum agricultural production is literally vital to the nation's economic recovery, we must differentiate between the good and the bad—the farmer's friends and the farmer's foes. It should be said at once that Mr. Lancum has brought to his task a very fair mind, and that his judgment, after forty years of experience in the field, must be accounted a careful pronouncement. For all that, as Mr. Lancum would be the first to admit, continuing controversy is by no means precluded ! One might, for example, be inclined to challenge the contention that poultry killing is still the major charge preferred by the farmer against the fox ; losses of lambs in the hill sheep areas are by no means negligible.

It is certain, however, that countrymen and townsmen alike will read this book with interest and pleasure. It is well presented and the many half-tone illustrations are amongst the finest animal studies included in a single publication.

C.D.H.

The Life of William Cobbett. (Third Edition). G. D. H. COLE. Home and Van Thal. 16*s*.

There are few thorough-going countrymen in the great field of English literature. Richard Jefferies, a remarkable writer, was after all only a looker on, a spectator of the rural scene. On the other hand, in Arthur Young we had a writer who both lived and farmed in the country. Another outstanding example was the author of *Rural Rides*, whose writing was remarkable alike for its engaging quality, personal force, and its inimitable style.

William Cobbett was a man of many parts. Born in 1763, he crowded into the seventy-two years of his life many experiences. In middle-age he was a farmer, experimenter, author, journalist, politician and political agitator—all at the same time. His brain matched his robust physique. Not always wise in his judgment, he often formed unsound opinions. Yet he was a considerable force in the land at a time when the ordinary people were becoming politically conscious. In the field of agriculture he is remembered for his intense dislike of the potato and his warm approval of the "Swedish turnip".

Almost completely self-taught (he went to work at eleven as a farmer's boy), Cobbett had no patience with the ignorance that could be dispelled by reading. It was mainly to help the illiterate that he wrote a grammar of the English language, and the same spirit was responsible for books on cottage gardening and cottage economy. These books are still basically sound and useful.

Mr. Cole undertook to finish the task, originally planned, but hardly begun, by the late F. E. Green, of writing the life of this remarkable Englishman, but the book, originally published in 1924, has long been out of print. The present edition (a reprint of the second edition with a few corrections) is therefore most welcome, though one wishes that the publishers could have arranged for a better style of printing. The chapter entitled *Rural Rides* was the original work of F. E. Green, and to country lovers is, I think, the most interesting part of the book.

A.H.H.

3009 Wt. 15 5/48 CN&Co 466

SUMMER SPRAYING OF FRUIT TREES:

Two highly efficient methods of

RED SPIDER CONTROL

The power of Red Spider to multiply is seldom fully realised. Six summer broods may reach maturity unless control is exercised at intervals throughout the season ! The alternative sprays recommended here are both excellent. Choice depends on your spraying programme.

FOLIOL plus ROTANE

If a summer petroleum is preferred, choose FOLIOL, a highly refined white oil which controls Red Spider in the egg, nymph and adult stages. Fortified with ROTANE (derris solution), the degree of control is stepped up to an exceptional efficiency, suitable for dealing with heavy infestations.

ROTANE plus SHELLESTOL H

This spray is recommended for those who wish to use derris alone or with Lime Sulphur. ROTANE, containing 5% crystalline Rotenone, is a very effective destroyer of nymphs and adult mites. The addition of SHELLESTOL H as wetter and spreader ensures even distribution and thorough penetration into the deepest mite-harbouring crevices.

Red Spider control has been the subject of much recent research. Findings of great interest and importance are published in a new Shell Technical Information Sheet, No. 255, "The Control of Fruit Tree Red Spider." A copy will be sent on request.

SHELL CHEMICALS LIMITED
(DISTRIBUTORS)

HEAD OFFICE : 112, STRAND, LONDON, W.C.2.
TEL. : TEMPLE BAR 4455
ALSO : 4, ST. MARY'S PARSONAGE, MANCHESTER, 3.
TEL. : BLACKFRIARS 0097
& KING EDWARD HOUSE, NEW ST., BIRMINGHAM, 2.
TEL. : MIDLAND 1742

HC.9/10

DDT DOUBLE STRENGTH POWDER

for GENERAL APPLICATION

★ Goes nearly twice as far for same results

Destroys: **CATERPILLAR, CAPSIDS, WEEVILS, MAGGOTS, MOTHS, MIDGES, FLIES (House and Cattle).**

10 lb. Tin and Duster ..	**20/-**
6×10 lb. Tins	**65/-**

(Wholesale Trade Supplied)

Specialists in DDT Formulations

BUGGES INSECTICIDES LTD · SITTINGBOURNE

DISASTER CAME WITH THE 1947 FLOODS

Take precautions today against avoidable losses.

The fight for economic recovery means that every animal is now doubly precious. We can no longer afford to lose a single one through avoidable cause. Weather cannot be controlled, but disease can. Ready to help are Evans veterinary products, the best that skilled research and modern science can provide for protecting and preserving the health of all livestock. Ask for them always by name.

Safeguard your pigs by inoculation with SWINE ERYSIPELAS SERUM

Protection lasts several weeks, the supplementary use of Swine Erysipelas Vaccine extending that protection for at least 12 months. Consult your veterinary surgeon regularly—preventive treatment against Swine Erysipelas is essential.

Made at The Evans Biological Institute by
EVANS MEDICAL SUPPLIES LTD

1690-35/C

A hen has to provide eggshells from the food she picks up.

It is not her fault if that food lacks the calcium - carbonate to form strong eggshells. A high calcium carbonate content is found in

'OYSTO' SHELL

THE ASSOCIATED GRIT COMPANIES
(A group of manufacturing companies within Universal and Allied Holdings Ltd.)
11, LITTLE COLLEGE ST., LONDON, S.W.1

By Appointment
Seedsmen to H.M. The King

DUNNS FARM SEEDS LTD.

SEED SPECIALISTS

SALISBURY

THE BOOK OF DUNNS FARM SEEDS, 1948 contains two strikingly interesting articles by Sir R. George Stapledon, C.B.E., M.A., F.R.S. (Scientific Adviser to Dunns Farm Seeds Ltd.) A copy will be sent post free on application.

★

Telegrams: Dunnseed Salisbury

Telephone: Salisbury 3247 (3 lines)

FOR FARM SANITATION

Approved by the Ministry of Agriculture and Fisheries

FROM YOUR LOCAL STOCKIST

SANIZAL

...WTON, CHAMBERS & CO. LTD., THORNCLIFFE, SHEFFIELD

FIRST AID ON THE FARM No. 1

BEFORE WORSE HAPPENS

COMMON COLD or catarrh reduces the stamina of birds and exposes them to roup, fowl-pox and other ailments. Laboured breathing at night with mucus at the nostrils and eyes, or inside the mouth, are signs of cold and catarrh. Eye and joint swellings may also accompany the condition.

Overcrowding, bad ventilation or a draughty house may be the cause and should be remedied. Bathe the bird's head and eyes over a bowl of lukewarm water—a pint bowl will do—to which a teaspoonful of tincture of iodine is added, removing the mucus from nostrils and mouth with the aid of cotton wool. Joint swellings should be painted with tincture of iodine.

This is an extract from "Iodine on the Farm." A guide to first aid in animal husbandry, the booklet deals with over 20 minor ailments of cattle, sheep and poultry. A companion booklet is "The Place of Iodine in Animal Nutrition." Copies will be sent to farmers or veterinarians who write to the Iodine Educational Bureau. There is no charge.

Iodine Educational Bureau
26 STONE HOUSE, BISHOPSGATE, E.C.2

Please mention the JOURNAL *when corresponding with Advertisers*

Please mention the JOURNAL *when corresponding with Advertisers*

Please mention the JOURNAL *when corresponding with Advertisers*

72-1-5-48

Agriculture

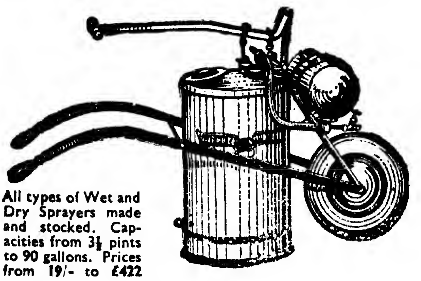
PUBLISHED 6d MONTHLY

SPRAYING MACHINERY

THE "ONDINE" Wheeled Pneumatic Sprayer

This machine has an 11-gallon Tank made of Brass Alloy for use with the usual washes, lime sulphur, tar-oil, etc. An automatic agitator is fitted. Overall length 5 ft. 3 in. Width 20 in. Weight 83 lbs.

The "**ONDINE**" which works at a pressure of up to 220 lbs. per square inch, can be used also as a pneumatic sprayer, *i.e.*, a one-man machine, and can be supplied either with pneumatic tyred or iron tread wheel. With it can be supplied any length of delivery hose and a large variety of Spray Lances or Guns of which full particulars are given in our catalogue.



All types of Wet and Dry Sprayers made and stocked. Capacities from 3½ pints to 90 gallons. Prices from 19/- to £422

Catalogue and full particulars from—

COOPER PEGLER & Co. Ltd.

Temporary Address:

"DELGENISH," CHIPSTEAD, SURREY

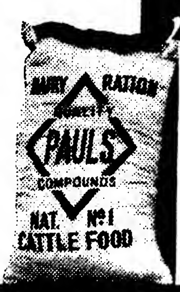
Quality

IN DIAMOND BRANDED BAGS

QUALITY FOODS for ALL STOCK

OBTAINABLE THROUGH YOUR LOCAL MERCHANTS

MILLS AT—
LONDON
FAVERSHAM
AVONMOUTH
MANCHESTER
HULL
KINGS LYNN
IPSWICH



R. & W. PAUL
LIMITED.

Manufacturers of **KOSITOS** (Regd.) *The Flaked Maize*

PAL CHEMICALS

at your service . . .

Pal Chemicals who first made plant growth substances available in Britain under the names ANAPAL, BETA-PAL, DEEPAL and METHAPAL are continuously engaged in research and development of new products for the benefit of agriculture.

MORTOPAL the first and foremost Hexaethyl Tetraphosphate insecticide has been available for some time as a nicotine substitute which is equally effective under low temperature conditions.

PALFUME Azobenzene and DDT insecticidal smoke generators are proving their high efficiency in trials at our Bray Research Station and by co-operating Growers. They will shortly be placed on the market.

THIOPAL is the name under which the remarkable new insecticide Parathion will be sold. This material appears so far to be a universal insecticide effective at extremely low concentrations. It is now available in small quantities for trial by approved research establishments.

PALORMONE Selective Weed-killer for use on cornland will soon be manufactured in large quantities. It is a highly concentrated but low-priced water-soluble form of 2,4-D for spray use.

PAL CHEMICALS LTD.

Palorit House,

11 Harrow Road, LONDON, W.2

COLCHICINE is now being manufactured for the use of plant-breeders.

Please mention the JOURNAL *when corresponding with Advertisers*

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

Editorial Offices: St. Andrew's Place, Regents Park, N.W.1 (*Phone* : *WELbeck* 7711)

VOL. LV — No. 4 — JULY 1948

¶ *Provided that the source is acknowledged in each instance, such articles and notes as are published in this Journal without any specific reservation regarding copyright may be reproduced in any registered newspaper or public periodical without special permission. The Ministry does not accept responsibility for statements made, or views expressed, in signed contributions to this Journal or in those reproduced from another source.*

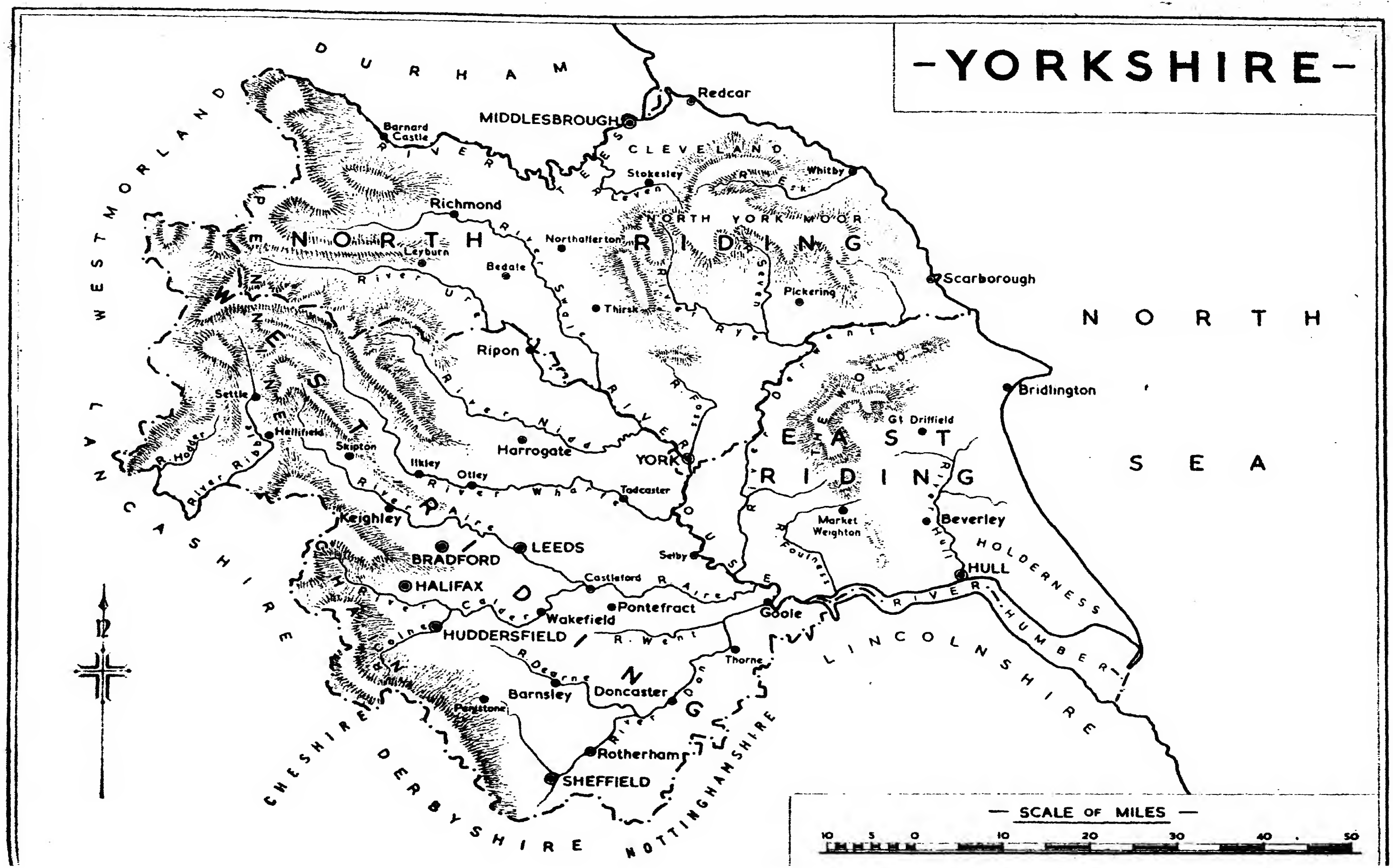
¶ *Further, the Ministry does not accept responsibility for any of the private and trade advertisements included in this publication.*

¶ *All communications respecting advertising in the Journal should be addressed to the Advertisement Contractors, Sawell and Sons Ltd.*, 4 *Ludgate Circus, London, E.C.*4. *Telephone: Central* 4353.

Contents

Cover Photograph

York Minster from the South-West .. *H. I. Moore*



-YORKSHIRE-
DURHAM
WESTMORLAND
LANCASHIRE
CHESHIRE
DERBYSHIRE
NOTTINGHAMSHIRE
LINCOLNSHIRE
NORTH SEA
NORTH RIDING
WEST RIDING
EAST RIDING
CLEVELAND
NORTH YORK MOOR
HOLDERNESS
PENNINE
MIDDLESBROUGH
Redcar
Whitby
Scarborough
Bridlington
Stokesley
Barnard Castle
Richmond
Northallerton
Leyburn
Bedale
Thirsk
Pickering
Ripon
Harrogate
Settle
Hellifield
Skipton
Ilkley
Otley
Keighley
BRADFORD
LEEDS
HALIFAX
HUDDERSFIELD
Wakefield
Castleford
Pontefract
Tadcaster
YORK
Selby
Goole
Thorne
Barnsley
Penistone
Doncaster
Rotherham
SHEFFIELD
Market Weighton
Beverley
Gt Driffield
HULL
RIVER TEES
R. Esk
R. Leven
R. Seven
R. Rye
River Swale
River Ure
River Nidd
RIVER OUSE
R. Foss
River Wharfe
River Aire
River Calder
R. Colne
R. Went
R. Dearne
River Don
River Ribble
R. Hodder
R. Derwent
R. Foulness
River Hull
RIVER HUMBER
— SCALE OF MILES —
10 5 0 10 20 30 40 50

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LV | No. 4 | JULY 1948

LAND USE IN YORKSHIRE

L. DUDLEY STAMP, C.B.E., B.A., D.SC., F.R.C.S.

Chief Adviser on Rural Land Use to the Minister of Agriculture and Fisheries

YORKSHIRE not only enjoys the distinction of being the largest county in England, but it can justly claim to be the one which can exhibit the greatest contrast in scenery and land use. Even if each of the three Ridings is considered as a separate county, we still find that the West Riding ranks as the largest administrative county in England and Wales, exceeding in area its nearest rival, Devonshire, by over 100,000 acres. The North Riding comes third in order of size, whilst the East Riding, though smaller, is still three-quarters of a million acres. Thus the three Ridings together total not far short of four million acres, or more than one-tenth of the total area of England and Wales.

The City of York lies on the River Ouse, approximately in the centre of the whole and where the three Ridings meet. We notice that Yorkshire as a whole falls naturally into three clear divisions—the Pennines and the Pennine slopes and valleys in the west, the lowland, generally known as the Vale of York, in the centre, and a varied series of uplands and valleys, or lowlands, in the east, including the Cleveland Hills, the North York Moors, the Vale of Pickering, the Yorkshire Wolds and Holderness. Each of these naturally marked divisions has its own distinctive land use and type of farming.

The Pennines extend from the high levels of the Peak and the North Pennine Moors, where much of the land is over 2,000 feet above sea level, to the lower ground, where moors give place to grassland and the Pennines fade into the margins of the Vale of York. The higher ground is usually occupied by moorland which is traditionally sheep pasture. Where the surface is ill-drained cottongrass moors are found. They are of little use agriculturally; nor are they attractive to the forester. These give place on the better drained slopes to *Molinia* or *Nardus* and in places to heather moors and to hill grazing where *Agrostis* and other grasses play a major part. In the northern part of the area much of the land is still occupied by the hill sheep farmer, but the southern area lies on the margins of the great Yorkshire coalfield. There much of the moorland has been used as the gathering ground for the water supplies of the neighbouring industrial towns, and there is extraordinary divergence in the attitude of the water supply companies to the use of their land, whether by human beings or animals. There are tracts where sport, in particular grouse shooting, has assumed a major importance and the farmer has tended to get squeezed out, sometimes quite unnecessarily, by the water supply companies on the one hand and the sportsman on the other. It is on the margins of the moorland that we find the small dairy farms engaged in production of milk for consumption in the nearby towns. In some areas much has been

accomplished in recent years in the reseeding of land which had been allowed to go back to rough grazing.

A common feature of the industrial fringes is the part-time farm, or smallholding, carrying a few animals and, in normal times, large numbers of poultry. Little of the land can be described as good—at best it falls into Category 6, Medium General-Purpose Farmland, in the Land Utilisation Survey of Britain scheme of classification.

The Pennines are drained by the famous tributaries of the Ouse—the Swale, Ure, Nidd, Wharfe, Aire, Calder, and Don—and the best land is to be found in the dales, or valleys, of these rivers. In some cases the waterside meadows afford excellent cattle pastures.

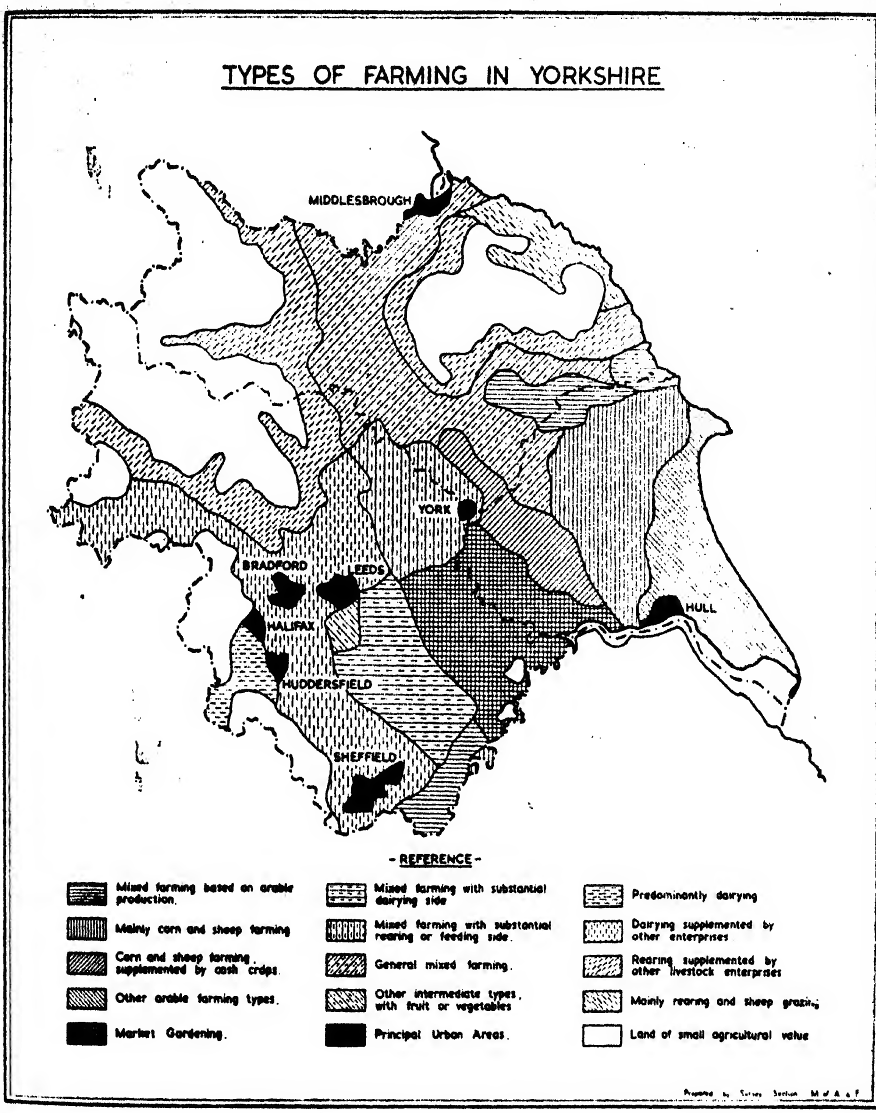
The Vale of York appears to the traveller by the old Great Northern route, which passes through its midst, a rather dull and uninteresting tract, essentially flat, though from the windows of the train one may catch a glimpse of the distant North York Moors or Pennine slopes. Underlying the floor of the Vale are Triassic and other sediments, but generally speaking the whole is occupied at the surface by the various deposits left behind when the ice sheets which covered Britain in the Great Ice Age melted and disappeared. In detail, soils and consequent land use and types of farming are very closely related to these superficial deposits. Crossing the Vale at intervals are ridges of coarse sands and gravels which are the moraines marking stages in the retreat of the ice. In olden days these afforded dry routes when much of the lower ground was flooded. Not unnaturally York grew up where one of these east-west land routes was cut through by the north-south water route afforded by the navigable Ouse.

Where the glacial deposits are sandy the soil may sometimes be so light and hungry as to be occupied by heathland, as it is north-east of York. Where the sand deposits are not quite as coarse we find light carrot and beet soils, useful though liable to blow and needing frequent marling. Elsewhere the deposits are more of the nature of silt and afford some magnificent arable soils, well suited to a variety of crops, because this is on the drier side of England, with the rainfall below 30 inches, but sufficiently far south to have a July average temperature of just over 60°F. Especially towards the north, part of the Vale is occupied by the heavier boulder clay, usually marked by an increase in the proportion of permanent grass, though affording some good strong wheat land. This merges into the red clay or clay-loam soils, derived from, or with much material derived from, the Triassic marls. In contrast, on the western margins of the Vale, overlying the Permian magnesian limestone, we find a very valuable arable belt, much in danger of being cut into for industrial use and housing by the steady eastward movement of the main centres of coal-mining and the expansion of Leeds.

Around the lower course of the Ouse and the estuary of the Humber there is much low-lying alluvial land, including a considerable proportion of warpland, built up gradually by allowing silt-laden flood waters, under control, to spread over the surface and deposit their natural load. Thus the Vale of York as a whole is a varied but valuable agricultural tract.

The Cleveland Hills rise from the fertile belt now, alas, ruined by industrial spread from Middlesbrough, which borders the lower Tees on the south. Except for the interruption afforded by Eskdale, the Cleveland Hills give place southwards to the North York Moors. The Moors themselves on the drier side of England, with a porous sandstone subsoil, are largely occupied by heather and afford some excellent sheep pastures.

South of the North York Moors is that fascinating flat-floored valley known as the **Vale of Pickering**, once a lake, the waters of which were piled up by ice blocking the natural exits. When the ice melted the waters



of the lake gradually dried up, but the whole has never been adequately or entirely drained. Thus some excellent soils of fenland type, capable of intensive cultivation, give place to marshy fields, still suffering from a water-table which is too high to permit of regular arable cultivation. The difficulty in the fuller use of the Vale is to secure adequate drainage in the absence of a natural fall. The Vale of Pickering is cut off from the Vale of York by the Hambledon Hills, partly forested, and through this ridge the River Derwent cuts in a beautiful gorge-like valley, well known to travellers by rail from York to Scarborough.

The Yorkshire Wolds lie to the south of the Vale of Pickering and occupy an important part of the East Riding. They consist of rolling chalk country, reaching the sea in Flamborough Head, but where the chalk country differs from that familiar to farmers in the south in that the chalk

is covered by glacial deposits, or boulder clay, so that the chalk itself only reaches the surface in some of the higher parts. The boulder clay has the effect of affording better soils than the chalk itself would do, and although the higher part of the Wolds may be occupied by fescue sheep pastures, in general it is true to say that the whole of the Wolds afford light land of barley-arable-sheep type.

The farming history of the area has been that of the Lincolnshire Wolds, or parts of East Anglia.

Holderness is that interesting peninsula which occupies the south-eastern part of the East Riding between Hull and the sea. It is a low-lying, boulder-clay-covered plain, with a gently undulating surface. If it were in a wetter part of Britain the clay or clay-loam soils would doubtless be devoted in large measure to grass, but it is on the drier side of the country and so is very largely under arable cultivation, and the relatively heavy soils provide some excellent wheat land.

Summarizing, the general position in Yorkshire is well seen from the map on p. 141, which has been reproduced from *The Types of Farming Map*, prepared in 1939 by the Economics Branch of the Ministry. This shows the northern part of the Pennine slopes to be mainly occupied with rearing, the southern part described as mixed farming with a substantial dairying side. In the Vale of York the northern part on the heavier land is described as general mixed farming, giving place around York itself to mixed farming with substantial feeding, and south of York to cash crop farming. The mainly rearing and sheep grazing of the North York Moors gives place in the Vale of Pickering to mixed farming based on arable production, but with a local emphasis around Scarborough on dairying. The Wolds, described as mainly corn and sheep farming, give place towards the Vale where the belt of light soils occur, to a similar type but supplemented by cash crops. Holderness the Ministry found difficult to classify and it comes into the category "other arable farming types".

BACKGROUND TO YORKSHIRE FARMING

H. I. Moore, M.Sc., Ph.D., N.D.A.
University of Leeds

To the many hundreds of visitors to the Royal Show who will enter Yorkshire through the heavily industrialized south part of the county, there will seem little justification for its title, "The County of Broad Acres". The factories and furnaces, coal pit-heads, smouldering slag heaps, and crowded, soot-begrimed houses which stretch monotonously for mile after mile, suggest nothing of the rich farming country that lies cupped to the north between the Pennines and the Wolds. But here in this county, spreading over its three Ridings, lies more than one-ninth of the agricultural land of England and Wales—an area diverse in soil, climate and farming systems.

Some idea of the magnitude of Yorkshire's farming can be gained from the following figures for the major crop and stock returns for June 4, 1947, together with the number of workers employed, upon whose effort the success of the various enterprises ultimately depends.

	East Riding	North Riding	West Riding
Crops and grass, excluding rough grazings	643,113	779,888	971,200
Wheat	75,649	45,153	65,794
Barley	99,900	94,294	46,779
Oats	60,645	76,919	90,930
Potatoes	24,706	28,244	51,422
Sugar beet	12,834	9,251	11,158
Vegetables for human consumption	21,442	2,877	20,847
Leys for mowing and grazing ...	93,940	88,154	88,625
Permanent grass	156,703	354,830	520,733
Rough grazings	15,202	204,746	282,323
Cows and heifers	28,111	55,323	97,808
Sheep and lambs	261,763	472,848	435,536
Pigs	38,622	41,284	69,162
Horses	14,644	22,408	29,552
Poultry	864,123	1,359,482	2,341,113
Workers	16,573	16,602	29,590

The broad impression which these figures convey is that corn is king in the East Riding ; in the North Riding there is rather less arable and more permanent grass ; in the West Riding, the large number of cows and heifers in milk calls for foods which give milk, such as grass and oats. The exceptionally high figures for poultry and potatoes are in the main a reflection of soil, climate and other natural features.

Soil and Climate From west to east the soil formations become geologically younger, ranging from the mountain limestone with its lofty, bare escarpments and green pastures to the broad expanse of chocolate-brown earth of the chalk represented by the Yorkshire Wolds. With a rainfall lessening from 50 inches or more in the west to around 25 inches in the east, there is a corresponding change from pastoral to plough farming. Thus the famous Craven country and dales of the West and North Ridings, for long regarded as the rearing grounds for cattle and sheep, grade into the rich cornfields of the East Riding. Between these formations one finds the millstone grit occupying a block of country roughly north of the Leeds-Bradford line, with the coal measures to the south. The millstone grit runs to high altitudes, and throughout the well-known "moors" there are innumerable outcrops of the rock itself. Poor land, showing high lime and phosphate deficiencies, inevitably gives rise to poor grass, with fine fescue, *Nardus*, heather and bracken as dominant species. Even on such naturally poor soil, however, productive swards of ryegrass, cocksfoot, timothy and clover are to be found, for Yorkshire was a pioneer of grassland improvement through the medium of the plough long before war compelled breaking-up in other parts of the country.

Where denudation has gone on and kindlier conditions prevail, the millstone grit gives rise to easy working but ever-hungry land. This is true also for the coal measures sandstone soils, which make up most of the arable land in the industrial areas of the West Riding. In sharp contrast with this the shales of the coal measures are heavy intractable clays, incapable of textural improvement by the addition of lime and for the most part, therefore, under permanent grass. So, south from Leeds to Sheffield in the truly industrial area of the West Riding, one finds naturally poor permanent grass interspersed with free-working arable—but arable which gives every indication of its inherent poverty. Many of the blots and scars upon the landscape in these parts are the inevitable by-products

of industry. Vast slag dumps and grim, grime-covered lakes, where subsidence has wrested land from the plough, are depressing sights for a farmer. But in all this murk and beneath the ever-present pall of smoke there are thousands of workers with hungry mouths to fill. The local farmers have, therefore, a vast potential market on their doorstep and cater for it by producing an abundance of fresh milk and vegetables.

Then comes a narrow strip of land, some 9 miles wide running north and south through the heart of Yorkshire and intersected throughout its length by the Great North Road. On either side of this great highway stretch the rich-looking, reddish-brown soils of the magnesian limestone, criss-crossed by the cream walls of the limestone itself and studded with picturesque villages whose red-roofed cottages and farmsteads are built of the same fascinating stone. As one might expect this area is essentially arable, and the crops, though not outstanding as far as yield is concerned, are of excellent quality, giving fine potatoes, first-class malting barley, good milling wheat, and supporting folded flocks on turnips. To the east of this soil formation and as far as the Wolds, sweeps the great Plain of York. Here is a wide range of soils—from light, blow-away sands to heavy, intractable clays. Frequently the change from one type to the other is so sudden as to occur within one field, thereby adding greatly to the difficulties of cultivation. Broadly, the Plain is devoted to mixed farming on a five-course rotation. To the north, and running from west to east, there is the oolitic limestone in the region of Pickering, a craggy type of land, thin and hungry and indeed so stony in parts that one wonders how crops can survive at all. Much depends on the seasonal rainfall and the humus content of the soil. The pastures are thin and subject to drought.

After the small fields and farms of West and North Yorkshire, the very spaciousness of the Wolds is breathtaking. This is a paradise for those who yearn for mechanized farming. Here are the largest farms in the county, with large fields admirably suited to power equipment. Once the home of the folded flock, and an important source of malting barley, the Wolds are now changing to grazing leys, water has been laid on, and even potatoes, beet and vegetable crops have been introduced. In the south-east corner of the county there lies the rich, heavy land of Holderness, now again, as of old, giving great returns in cereals and livestock.

Rearing Farms of the West Against this background and by the efforts and ingenuity of the farming community, there have arisen clearly defined systems of farming which, though modified by the war, remain essentially much the same today as in the past.

The grassland areas of the west are still regarded principally as rearing grounds for sheep and cattle which are passed to the more congenial lower lands for finishing or production. The markets of Craven still provide replacements for the milking herds of the industrial region. Whereas fifty years ago the farms were tenanted solely by the Scotch Blackface and the Shorthorn, the former has now been almost entirely replaced by the Swaledale, and the Shorthorn, though still supreme, mingles here and there with Ayrshires and Friesians, indicating the break with tradition effected by some pioneer. It was, however, the setting up of the Milk Marketing Board which converted many farms in this area from rearing, carried out in conjunction with butter- and cheese-making, to milk selling. The advantage of the monthly milk cheque and the convenience of leaving the churns on the roadside to be picked up by an efficient transport service has given new life and impetus to a region which in the lean 'twenties could scarcely eke out an existence from the land. The advantages of

livestock improvement, of grassland reseeding, even of silage-making, have penetrated the innate caution and conservatism of dale and fell.

Dairy Farming The industrial West Riding has for long been an intensive milk-producing area. On these relatively small, inherently poor farms, run mainly by family labour, the art of extracting milk from cows reached a level before the war excelled by none. The pastures, deficient in lime and phosphate, contributed little to the maintenance of the stock which, in consequence, consumed large quantities of purchased concentrates, summer rations differing very little from those of winter. Clean milk production was thoroughly understood, and the cows at the end of their lactation were either fat enough to be sold for meat or were returned "dry bag" to dealers in the grassland districts where, after a period of recuperation, they would in due course be sold back to the intensive areas as " new calvers". Pigs and poultry proved useful adjuncts—again maintained on purchased concentrates. Small wonder, therefore, that this region viewed with marked concern the cessation of abundant feedingstuffs on the outbreak of war. Small wonder, since the farms were so small and the soil so poor, that the ploughing-out campaign was received with so little enthusiasm. Yet by direct reseeding and by growing kale and forage mixtures, the majority of the farmers were able in due course to adapt their system of farming to the new conditions. The West Riding County Agricultural Committee was one of the first in the country to start a scheme for reseeding grassland at an all-in cost, and in not a few cases farmers married hill farms, where the stock could be reared, to the industrial area farms where the stock were milked.

In contrast with the milk and feed system, the Cleveland lowland area of the North Riding has always proudly maintained a high standard of dairy farming in association with arable land. The soil, it is true, can be classed as one of the best in the county, and the cows can secure most of their needs from the arable crops and leys. The holdings are bigger and there is naturally greater scope than in the industrial area. This part of Yorkshire has always bred enterprising, adventurous farmers, with the result that here originated the intensive system of grassland management, here the first grass drying plants were installed, and the first combines used. The farmers here pioneered milk recording and bail milking, and the folding system for pigs and poultry. Here indeed, one finds some of the best farming in the county, and crops and stock are ideally blended to secure maximum output. Then too, in the Pontefract area of the West Riding the diversity of the farming enterprises is such as to constitute " mixed farming," but there is a strong tendency for many of these farms to revolve round the dairy.

Arable Farming As might be expected it is in the eastern half of the county, with its lower rainfall and greater sunshine, that arable farming predominates. On the Wolds the acreage of permanent grassland is negligible, and the one-year ley is the chief source of pasture and fodder. For long the traditional Norfolk four-course system of roots, barley, seeds and wheat reigned supreme, and it was only the exigencies of war that brought longer rotations into being.

Unique as a soil type is the warp land of the Selby-Goole area. This deep, rich soil is alluvium from the Humber, partly laid down under natural conditions and partly as the work of man who, by means of sluice gates and a series of open drains, has harnessed this means of soil formation to his use. Until last year warping, as the process is termed, had not been practised for some twenty years but the practice has been resumed recently in the Yokefleet area. Warping is made possible by the fact that the Ouse, which carries

a suspension of soil particles from the plain of York, and the Trent laden with particles from the keuper marl, meet the incoming tide of the Humber carrying mainly chalk sediment from the denudation of the East Coast. This mixture of silts is allowed to flow over land enclosed within high banks, and after its deposition the water is returned quickly to the river at low tide through an elaborate system of ditches and sluice gates. The process is of great practical value, for when complete, and the new soil is sufficiently dry to be cropped, a start can be made with rich virgin soil. Considerable engineering skill is involved and the control of the water, to secure the greatest deposits using mainly spring and autumn tides, is a highly skilled task. The amount of new soil deposited during the season varies, but it is on record that from June, 1829, to January, 1830, in one enclosure of 160 acres, from 1 to 3 feet of silt was secured, though admittedly, this large deposit is rather abnormal. Concentration on beet, potatoes and wheat as the principal crops is common, and it is an almost invariable rule to plough down the aftermath of the clover ley as a means of maintaining fertility. Livestock on most of the farms is kept mainly to provide manure for the crops.

Other areas where practically three-quarters of the land is under arable crops include part of the Vale of Pickering and the magnesian limestone soils referred to earlier. In the Pocklington area much of the land is devoted to cash crops—wheat, barley, sugar beet, potatoes, and carrots. As already indicated the Holderness area is also mainly arable, the heavy boulder clay soil being particularly suitable for crops such as wheat and beans.

Market Gardening A considerable area of land has always been devoted to market gardening in Yorkshire, but during recent years this has tended to expand, and since 1939 many farmers have incorporated vegetable crops in their rotations. The district south of Leeds is famous for its rhubarb, over 50 per cent of the total acreage devoted to this crop in England and Wales being concentrated in this small region. Marketing begins about Christmas and continues for three to four months. In conjunction with this crop, broccoli, peas for picking green, cauliflowers, and cabbage are grown, since there is a very large market for these vegetables nearby. The other market-gardening area of considerable importance is near Hull, where, as a result of the lead given by Dutch settlers, glasshouse cropping is now carried out extensively. Here lettuce, tomatoes and other salad crops are grown, mainly under the Dutch light system.

Now what of the holdings from which this impressive array of produce comes ? According to the National Farm Survey, 1941-43, the distribution of holdings was as follows :

Size of Holding (*Acres of Crops and Grass*)	5-25	25-100	100-300	300-700	700 and over
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
East Riding	25	31	34	9	1
North Riding	26	39	32	3	–
West Riding	36	43	19	2	–

The West Riding has the greatest concentration of small farms, and the East Riding some 9 per cent of the holdings over 300 acres. As might be

expected the West Riding authorities in particular have established a large number of smallholdings, the demand for which, as in other Ridings, is very heavy.

This then is the background picture to the farming in this great county. From whichever direction the Royal Show is approached, the farm lands of Yorkshire will offer something of interest, perhaps inspiration also. Bleak uplands, sheltered valleys, expansive wold land, and the patchwork quilting of numerous smallholdings, the rich warp land, limestone and loams or the hungry grit, shales or peat—these are the raw materials with which Yorkshire farmers have, by their skill, enterprise and determination, established a record of which they may well be proud.

AGRICULTURAL EDUCATION AND RESEARCH IN YORKSHIRE

Norman M. Comber, D.Sc., A.R.C.S., F.R.I.C.
University of Leeds

AN organized and comprehensive scheme of agricultural education in Yorkshire came into existence in 1890. There had, of course, been some agricultural education work long before that. Some had been stimulated by the Yorkshire Agricultural Society which had been in existence since 1837, and the activities of such bodies as the Yorkshire Central Agricultural Association, founded in 1832, and certain clubs designed primarily to promote legislation in agricultural interests, gave rise to some education work. Certain individual teachers are known to have given some instruction in agricultural science in their schools and colleges.

The Yorkshire College The Yorkshire College, originally founded in 1874 to teach and develop the sciences pertaining to Yorkshire industries, and which ultimately in 1904 became the University of Leeds, was in 1890 a constituent part of the Victoria University, which also included colleges at Liverpool and Manchester. In this year a sum of money was provided by the Government to enable County Councils to develop technical, including agricultural, education, whilst the Board of Agriculture, as a State Department, had been established in the previous year. The granting of this money and the formation of the Board of Agriculture encouraged certain Yorkshire agriculturists to see Mr. Chaplin, the first President of the Board of Agriculture, about the formation of an Agricultural Department in the Yorkshire College. The result of this was the formation of a committee under the chairmanship of Lord Herries, which prepared a scheme for financing a Department of Agriculture. A small sum—a little under £500—was contributed by private subscription. The three Yorkshire County Councils agreed to contribute £1,000 a year each from the new funds available for technical education, and the Board of Agriculture agreed to supplement these payments.

James Muir was brought from the Royal Agricultural College and made the first Professor of Agriculture, and the teaching work of the department began with three students and considerable criticism in the press. This

beginning may have appeared inauspicious at the time, but the numbers of students entering the College rose to 33 by 1897.

In addition to courses in the College, courses of instruction in the evenings at various centres in the county rapidly became very popular, and the staff was not always able to meet the demand. They consisted of an organized series of lectures, usually ten, and these were held in 1891 at 43 centres; by 1895 the number had risen to 89.

Besides these, some demonstration and experimental plots were started in 1892, and a scheme for the institution of gardens for instruction in horticulture was formulated in 1896.

The Manor Farm, Garforth Professor Muir resigned in 1897, and for a year or two, before Professor J. R. Campbell* was appointed to succeed him, the late Sir William Somerville, then Professor of Agriculture at Newcastle, gave some technical assistance, particularly in the planning of experimental field work. At this time the East and West Riding County Councils leased the Manor Farm, Garforth, for educational and experimental purposes, but the North Riding County Council, while participating in the financing of the Department of Agriculture in the College, did not participate in this farm scheme. The leasing of the farm raised the question of moving the Department of Agriculture from the College premises in Leeds to the Farm. Exactly the same question arose about 1918-19, when the present building of the Department of Agriculture in Leeds was about to be started. The decision each time was to leave the Department in Leeds, and one ventures to hope that the wisdom of this is no longer seriously questioned.

Although the Department was not moved to Garforth, a small block of buildings, including laboratories, a classroom and a dairy were erected at the farm and opened by the Chancellor of Victoria University, Earl Spencer, in 1901. The activities at Garforth were very diverse, including feeding and manurial experiments, variety trials, and some rather more academic researches by members of the staff. The dairy was always a very prominent feature of the work. In the course of years, however, the soil at Garforth became seriously affected by the acidity of an industrial atmosphere, and while this was not the only reason for leaving the farm in 1928, it was certainly a contributory cause.

The University of Leeds and The Yorkshire Council for Agricultural Education It was stated at the beginning of this article that the three Yorkshire County Councils contributed from the beginning to the work of the Agricultural Department in the Yorkshire College. The County Councils also from the beginning had considerable responsibility for the management of the Department. For each of its technological departments the Yorkshire College had an advisory committee, including a number of relevant industrialists, and an advisory committee for the Department of Agriculture was established in 1890 under the chairmanship of Lord Herries, who had been so largely responsible for bringing the Department into existence in that year. On this advisory committee were the representatives of the County Councils, and all the work of agricultural education that in other counties was carried out by the County Councils independently of any college was in Yorkshire carried out through the College staff. Throughout its history until a few years ago the scheme of agricultural education in Yorkshire has been unique in the fact that all agricultural education has been within the framework of one

*Professor Campbell was succeeded in 1900 by the late Professor R. S. Seton, who retired in 1932.

scheme ; work at College (and afterwards University) level and the County Council work in agricultural education has been the responsibility of one and the same staff.

In 1902 the North Riding County Council joined the other two Councils in the responsibility for the lease of the farm at Garforth, and the three County Councils formed a Joint Council which, with a few added members, was known as the Yorkshire Council for Agricultural Education. This body was responsible to the County Councils for the work at the farm and continued to be the Advisory Committee to the College on its Department of Agriculture. In 1904 the College became the University of Leeds, and the University continued to recognize this Council as its Advisory Committee. It may be of interest to note certain unusual features of the administrative arrangements whereby University and county work were dealt with in one comprehensive scheme. The Department of Agriculture had been a department of the College and automatically became a department of the University, and the only legal contract of employment of members of the staff was with the University Council. In practice, however, the Yorkshire Council for Agricultural Education, essentially a County Council body, controlled the Department, financed it just as if it were a county council activity earning a percentage grant from the Ministry of Agriculture, dealt with appointments to the staff, promotions and such matters, the University Council formally accepting the recommendations of the Agricultural Council. The farm, however, had no official connection with the University, but was nevertheless used by members of staff exactly as if it were the University farm.

It is not surprising that these administrative arrangements sometimes seemed to those not involved in them as rather peculiar, and they were indeed peculiar, for the whole arrangement was one that did not admit of any legal agreement between the University, to which the Agricultural Department officially belonged, and the County Councils which virtually controlled it and made a farm available. But there was no other way in which all spheres of agricultural education could be coordinated in one scheme, and its success through many years was due in no small measure to the sympathetic understanding of University affairs on the part of successive Chairmen of the Yorkshire Council for Agricultural Education. Notable among them was the late Major J. W. Dent, who succeeded Lord Herries in 1908 and occupied the chairmanship of the Agricultural Council for twenty years, serving at the same time as a leading member of the University Council and an Alderman of the West Riding County Council.

In the early years of the history of the University the majority of agricultural students took either a diploma course leading to the National Diploma in Agriculture, or a shorter course, and the number of undergraduates, that is, those reading for a degree, was small. As time has gone on the diploma and other students have become relatively few, and at the present time all the accommodation of the Department is filled by degree students.

The research work of members of the staff became reputable throughout the country in quite early years of the Department's history. The work of Dr. Charles Crowther led to the establishment of a Research Institute in Animal Nutrition in the Department in 1913, but this was removed to Cambridge after the first world war.

It had always been the policy of those responsible for the Agricultural Department from its beginning that members of its staff, in addition to teaching and research work, should be available to advise farmers in Yorkshire on specific problems, and this advisory work has always occupied a large proportion of the time of the staff and has necessitated a rather larger staff

than would have been required for teaching work alone. The wisdom of this policy is indisputable. Not only were the resources of the Department made available to practising farmers, but members of the staff were kept in continual and practical contact with the problems of the farms in a way that greatly enriched their teaching.

The Years Between the Wars During the first world war there were no students in the Department of Agriculture, and the staff devoted itself entirely to problems of food production. After the cessation of hostilities, however, considerable developments took place. The number of degree students admitted when the Department re-opened was at a higher level than ever before and the University (on the advice of the Yorkshire Council for Agricultural Education) arranged for developments in the county work by the appointment of a number of District Lecturers, who had to reside in different parts of the county. This arrangement facilitated the development of county classes and of advisory work, the formation of Farmers' Discussion Groups, and in due course the development of Young Farmers' Clubs, which went on from strength to strength, leading to the formation of the Yorkshire Federation, subdivided into regions centring around the District Lecturers. Attempts were made to establish a number of day classes, to meet one day a week, for young people who were employed on farms. While some successful work was done in these classes, they did not develop to the extent that was hoped and had to be abandoned at the outbreak of the war in 1939.

It was shortly after the end of the 1914-18 war that the Ministry of Agriculture set up the arrangements for the Provincial Advisory Service, whereby England and Wales was divided into thirteen areas, and Government funds were made available to an appropriate agricultural institution in each province to enable it to employ a staff of agricultural specialists for the primary purpose of advisory work among farmers of the province. The Ministry invited the University of Leeds to become the advisory centre for the Yorkshire Province. Such work, however, had already long been established—since the first days of the Agricultural Department of the Yorkshire College—and the proffered grant was not accepted by the University for a number of years. This was admittedly partly due to a fear that if the salaries of certain members of the University staff were met entirely from a government grant, some measure of government control over the work of those members of staff might intrude itself into the cherished autonomy of a university. After some years, however, in the first instance with rather special arrangements between the University and the Ministry of Agriculture, one or two members of the staff were earmarked for advisory work, and ultimately the complete scheme was adopted here.

Askham Bryan and the Farm Institute It was in 1927 that the Yorkshire Council for Agricultural Education, in anticipation of leaving Garforth in the following year, arranged for the purchase by the County Councils of two farms comprising 349 acres at Askham Bryan, near York. On this farm the kind of experimental work was carried out that had previously been conducted at Garforth, and it was also intended at the time of the purchase of the farm to establish a residential Farm Institute to complete the comprehensive scheme of things in Yorkshire. It was not, however, until 1935 that a definite decision to go on with this scheme was made, and the building of the Institute was very near completion when the second world war broke out.

The Second World War Period and Since It has been stated that the agricultural student in Leeds disappeared altogether during the first world war. During the second war, however, the number of applicants for admission to courses, which had been increasing rapidly before 1939, increased to a number which was beyond the possibilities of accommodation in the Department. The greater part of the county work for which the Department was responsible had either to be abandoned for the duration of the war or adapted to assist in food production and transferred to the charge of the War Agricultural Executive Committee. All the District Lecturers and certain other members of the staff were seconded to these Committees, and the staff in Leeds was occupied only by its teaching work and the specialist advisory service. The completed Institute at Askham Bryan was used at first for training recruits to the Women's Land Army, and subsequently it was occupied by the National Institute of Agricultural Engineering. It will thus be seen that the rigorous necessities of war conditions separated county and University work, but other considerations, particularly the requirements of the Education Acts, have determined that the separation of county and University was not to be merely a temporary war-time arrangement. The future requirements of the County Councils in respect of county and farm institute work could not be implemented through a university, and so today that work and the farm institute work which is now beginning at Askham Bryan is controlled by a County Council arrangement which is officially independent of the University. The specialist advisory work remained in the University during the war years, but the establishment of the National Agricultural Advisory Service involved its separation from the University in October, 1946. While, therefore, recent major national developments in agriculture and in education have administratively broken up a unique scheme of agricultural education in which teaching at all levels, advisory and experimental work, were all in one organization, the experience of half a century of coordinated work has established traditions in agricultural education in Yorkshire which we may confidently hope will ensure the happiest relations between all those who are to be concerned with it in the future.

WOLD FARMING IN EAST YORKSHIRE

W. W. Gatenby, M.Sc., N.D.A., N.D.D.
National Agricultural Advisory Service, Yorks and Lancs Province

REPRESENTING the most northern extremity of chalk land in Great Britain, the wolds of East Yorkshire cover some 300,000 acres, or rather more than one-third of the Riding. These rolling uplands are in a crescent shape, one end projecting eastwards into the North Sea at Flamborough Head, and the other sweeping south to the Humber. From the scarp edge on the north and north-west there is a general slope from the highest point of 810 feet in a south-easterly direction down to the glacial lowland of Holderness. The Wolds chalk differs from that further south in being much harder; some will even serve as building stone.

At the higher elevations the soil is shallow, containing many chalk particles or in some areas flints. On the lower Wolds the soil tends to be deeper, and on the eastern side, adjoining Holderness, the glacial drift overlies the chalk to give extremely fertile land with good natural drainage. The soil in the bottom of the several Wold valleys is usually of a gravelly nature and overlies a deep, hungry, gravel subsoil.

Historical Although inhabited from very early times—as far back as the days of the Stone Age people, who preferred this comparatively open and dry country to the then surrounding marshy forests, in spite of the bleak, exposed situation—enclosures on the Wolds came comparatively late. It is obvious from the general well-planned lay-out of the farms, and the straight-sided and regular-shaped fields, that the experience of surveying and farm planning gained elsewhere was put to good use. A very necessary protective belt of trees along the north and east sides of the homesteads forms a typical feature of the many outlying farms.

By reason of the great depth of the chalk and its high porosity, springs are seldom found on the Wolds, and then only of a very intermittent nature. Much of the drainage from the chalk mass occurs on a fairly clearly defined spring line around the fringe of the Wolds. Apart from a few cases, wells have to be sunk to a very considerable depth to ensure a reliable supply in dry seasons, and in the past this lack of water largely restricted the type of farming that could be followed.

So-called dew ponds and rainwater storage cisterns had often to provide all the needs of livestock, which meant that before a dry summer had advanced very far the situation became serious. One or two men and several horses could find a full-time job carting water from some larger pond in a distant hollow which was still holding out, or from a deep well in one of the valleys. Water for human consumption had, of course, to be carted in this way all the year round, unless filtered and boiled soft water was used instead. Tales are still told of cattle being driven daily several miles to springs on the edge of the Wolds—treatment hardly calculated to put on beef or to increase milk yields—and quite naturally it was unusual to find many permanent herds of cattle under these conditions. In winter the stores bought in for feeding could manage quite well with the water from the large quantities of roots consumed, supplemented by pond or cistern, and in summer the sheep just had to manage without.

Traditional When the enclosure movement had reached finality, little permanent grass remained—only the sides of the valleys or "dales" too steep to plough and the horse pasture adjoining the homestead, which would have to carry sheep when not on seeds or roots. The four-course rotation was general, but later there was an extension to a five-course on the better land at lower elevations by the inclusion of wheat sown on the seed-land thus: roots – oats – seeds – wheat – barley. Mowing of seeds was seldom practised; the requirements of the sheep would not permit this, and a strictly all-clover mixture was the rule.

Folded sheep—a permanent flock, and Leicesters predominating—consumed the greater part of the roots. The remainder would be carted off to feed the cattle in the yards.

Farms on the average are large, often 500 acres or more, and this might have called for sixteen working horses—Shires in the early days, with a trend to the Clydesdale later. Large teams were the rule, up to four abreast in the field; two pairs hitched tandem to a large wagon carrying up to 4 tons of grain was a common sight on the roads.

The outlying farms were not well equipped with cottages, and single men hired by the year at Martinmas, living in the farmer's house or in a separate house of the foreman, comprised most of the staff. Casual Irish labour met much of the needs of harvest, the peak period in the year.

There was a strongly held belief in shallow ploughing; 4 inches being said to be ample in order to avoid burying sheep manure and soil fertility beyond the reach of the crop. On wheat-growing farms the seeds received most of the farmyard manure towards the end of the summer, and the crop would be put in by the time-honoured method of ploughing and press drilling, still a popular practice and well adapted to present-day equipment.

Fairly heavy dressings of coarsely ground bones, in later years replaced by superphosphate, applied by a combined seed and manure drill gave good results with roots, and this had to serve for the following crops in the rotation too. Both winter- and spring-sown corn might receive a top dressing of salt or kainit and nitrate of soda.

Wold farming reached an extremely high standard within the prevailing natural limitations. The level of craftsmanship of the workers was high and, by reason of the large staffs of resident labour, a very noticeable team spirit was built up, each farm vieing with its neighbours in all matters of farming practice.

Pre-War Problems With sheep and cereals as the main source of income, Wold farming was sorely hit by the depression of the early 'twenties, and many found it difficult to change the farming system so that the drain on capital resources could be stopped. Much land was sown down to grass, not usually with the idea of its forming part of a planned rotation, but primarily to cut expenses. Because of lack of water, sheep formed the main class of grazing stock, and there was a marked trend away from the large Leicester hogg to Down-cross fat lamb production. The absence of grazing cattle frequently led to a too heavy sheep stocking, with its consequent disease problems; in some years losses due to worm infestation were very heavy. A sporadic development of milk production under difficulties also took place. Yarded pigs often replaced bullocks and proved helpful. Some mechanization of cultivation was adopted to reduce costs.

During all this time the fertility of the area undoubtedly declined markedly, but very few farms actually became derelict.

War-Time Farming The rapid change to war-time farming gave new life and hope. Here was a chance to show what Wold farming could really do, and it was not long before much of the slack of pre-war years had been taken up. Heavier dressings of fertilizers increased yields on the old arable, and the ploughed-out leys proved capable of growing very satisfactory corn crops. The traditional skill of the farmer and his men ensured a high level of efficiency from the new machinery which had to be brought in to cope with the increased area of land under the plough.

In June, 1943, the military authorities took over more than 100,000 acres towards the north of the Wolds for almost unrestricted use by tanks and armoured divisions, in preparation for subsequent operations on very similar terrain across the Channel. Immediately prior to this date, all sheep were removed from the area. The growing of roots was reduced to one-third of the rootfall to meet the needs of the yarded stock, and the remainder of the fallow break was sown with mustard for ploughing in.

In spite of extensive damage to all crops and to the land surface which unavoidably followed intensive cross-country manœuvres, quite 60 per cent

of the harvest was secured, even in the worst year. To carry out field work under these conditions called for a certain amount of ingenuity, to say the least, and it was found advisable to bring all implements to the shelter of the buildings each night, the homesteads being out of bounds to tanks.

Eventually the military exercises ceased and the farming community was able to start removing the scars of the occupation. To level the more deeply tank-rutted fields, use had to be made of heavy tracklaying tractors and cultivators, working to a depth of 18 inches or more—rather different treatment from the traditional shallow ploughing ! The gappy and often largely obliterated fences had also to be tackled somehow : those on the farm boundaries were either made good with posts and wire, or where a fair amount of quickthorn remained alive, all growth was cut and layered and the totally destroyed lengths filled in with young thorn plants. Bull-dozers made short work of some internal fences.

Apart from the effects on the fences, and the deep tank tracks which still show in the daleside pastures, and track marks in cornfields at certain seasons, little evidence remains of this hectic period in the history of the Wolds. The sheep population of the area is slowly reappearing, with Leicesters still retaining a considerable popularity.

Recent Developments During the years immediately before the war an arterial water grid was laid to practically all the Wold villages but the supply did not penetrate to many of the outlying farms. The full importance of this was probably not realized at the time, but under the stimulus of the grant-aid scheme and its attendent priorities, more and more farms have been reached. Not only the homesteads but on some farms the majority of the fields also now have a piped supply, and this may well have an important bearing on future developments. Now that a proper stocking of cattle can be carried, the incorporation in the cropping system of a ley to stand longer than one year, and to replace largely the seeds and roots of the older rotations is now practicable.

The old-time Wolds farmer made no attempt to conceal his dislike of milk production—a feeling fully endorsed by his men. Today, however, many dairy herds, some pedigree and T.T., are being built up on a very sound basis, and with farms so long lightly stocked, the risk of disease is much reduced. Even pedigree beef herds have been started in some places. Such livestock units can fit in well with the working of a large arable farm, provided the necessary labour is available. Here, of course, we come up against the old problem of lack of cottages ; some are now being built but many more are needed.

Providing an interesting development on the better type of Wold land, potato growers, migrating from eelworm-infested areas, have ploughed deeply with heavy tackle, manured heavily and grown satisfactory crops. Recently, too, stock seed potatoes have been grown on the higher land with considerable success.

Although many Wolds fields are on steep hillsides, wheel tractors are used almost exclusively ; tracklayers are seldom seen. The use of combine harvesters is gradually increasing and combine grain and fertilizer drills have proved their worth, but unfortunately they are difficult to obtain. Because of the large-scale methods of working, the Wolds are well suited to mechanization of corn growing ; and an appreciation of this fact has enabled the farmers to overcome many difficulties during recent years.

WARPLAND FARMING

J. Gibbons, M.Sc. and A. H. Fitton, B.Sc., N.D.A., N.D.D.
National Agricultural Advisory Service, Yorks and Lancs Province

THE Vale of York comprises a fair proportion of Yorkshire's broad acres and undoubtedly contains some of its best farming land. Through it flows the Yorkshire Ouse, gathering up on its way to the Humber many important tributaries from the eastern valleys of the Pennines (the Yorkshire dales), including the Swale, the Ure, the Nidd, the Wharfe, the Aire, and the Don. Perhaps it is truer to say that the river meanders rather than flows, as even at York, some 60 miles from the mouth of the Humber, it is only 24 feet above sea level, and is tidal as far inland as Naburn Lock, which is within 3 miles of York.

Warping—Natural and Artificial In the region of the lower reaches of the river there are considerable areas of warp soil, which consists of alluvial material deposited from muddy water brought to rest. The formation of warp is possible only in the case of certain tidal rivers. The deposited soil contains about 10 per cent calcium carbonate, and, though normally of a heavy texture, it varies as between the different reaches of the river and different tributaries. It is said that the heavy low-lying riverside land of the area is warp which was formed naturally hundreds of years ago.

Artificial warping has also been carried out over a large area. The process consists of banking in the area to be warped, so as to form a kind of lagoon within which controlled flooding from the tidal river is arranged by means of a warping drain. The flow of water is controlled by sluice or clough gates which are opened at certain high tides, thus allowing the river water containing alluvial material to flow into the lagoon. The water is retained until the alluvium has been deposited, and is then allowed to flow off, leaving a thin deposit of silt. This process is repeated many times, usually over several years, until a sufficient thickness of warp has accumulated. Normally the area is first allowed to develop a natural vegetation which is grazed by stock for a period, after which the fields are marked out, and the land drained and brought into cultivation.

The need for a complete system of drainage is one factor adding materially to the cost of warping ; and not only is under-drainage of the individual fields necessary, but the low-lying nature of the land also necessitates adequate and well-maintained ditches and main waterways with clough doors to prevent the tidal water gaining access. The total cost of the operation is high, and in consequence, in spite of the value of warp land, very little warping has been done for many years ; although a 60-acre "block" is being treated at Yokefleet at the present time. In general, however, we have to thank our forefathers for our warplands.

Fairly Large Farms Statistical data concerned exclusively with the warp soils are not available, but the figures for the Goole Rural District, an area which is largely warp, may be taken as giving a picture of the position on that soil type.

	percentage of total Goole area
Holdings under 25 acres	2
,, 25–50 ,,	4
,, 50–100 ,,	17
,, 100–150 ,,	12
,, 150–250 ,,	26
,, 250–500 ,,	28
,, over 500 ,,	11

It will be observed that most of the area is farmed in fairly large units, 65 per cent consisting of units of over 150 acres; and in view of the fact that the area is almost exclusively under arable cultivation and in a high state of fertility, this means that the units are also large in terms of gross output. The 50–100 acre group is high compared with the 100–150 acre group, largely because of the number of County Council smallholdings in the area. The County Council has an estate of about 3,000 acres, comprising some fifty agricultural holdings, in addition to a number of cottage-holdings. The estate was established over a period from about 1912 to 1930 and has proved to be a most successful venture.

Potatoes Pre-eminent If one could speak of a traditional rotation for the district it would probably be a four-course, as follows: potatoes (or roots) — wheat — oats — seeds. This has been modified in recent years in several ways, one being the substitution of a rootbreak for seeds once in eight years on account of clover sickness; another consisting of the omission of the second corn crop, and with roots replacing seeds in every other "course," this gave a six-course rotation with one-third of the arable land under a rootbreak. There have been other variants, peas in some cases replacing part of the seeds-break.

The potato crop has been and still is the king-pin of the farming systems on the warp, although the incidence of potato root eelworm has led in recent years to an increased acreage of sugar beet and other crops. Potato eelworm has become a serious problem on many farms, aggravated during the war years by the drive for maximum production and the modern tendency to depart from fixed rotations. The indications are, however, that warp farmers are beginning to master the problem of dealing with eelworm and are cropping less intensively with potatoes. In this connection a good deal of work has been done by the Advisory Service in examining soils and offering guidance as to the degree of eelworm infestation, in order that badly affected fields might be avoided; this is the only practicable treatment available. It is hoped in future to maintain and even extend this work so as to reduce to a minimum the risk of serious eelworm infestation, whilst at the same time making possible the growing of as large an acreage as can be attempted with safety. Where the growing of potatoes is unwise sugar beet is the most widely grown alternative cash crop.

Not only do the warp farmers grow large acreages of potatoes, but they are experts at the job, paying close attention to thorough cultivation, adequate fertilizing, use of good seed and early planting. Once-grown warp seed is always in demand. As regards cultivation, many of these soils can be ploughed to a depth of 18 inches without bringing up subsoil, and full advantage is taken of this fact. Crawler tractors are in big demand by the larger farmers and by contractors who undertake a good deal of this type of work. Before the days of tractors steam tackle was used. Consequently yields are high, 10–12 tons per acre being common, and even 14 tons per acre is not unknown. These high yields are as much due to the skill and care in growing the crop as to the fertility of the soil.

Recent Changes in Farming Practice Another of the major crops in the area is wheat, and very heavy yields are often obtained. Strong-strawed varieties are grown to stand up to the residues of the heavy dressings of fertilizer given to the potato crop. The older variety, Victor, has long been popular, although in recent years it has been partly replaced by the shorter-strawed types, such as Jubilégem, Hybrid 27, and Bersée. Only a small amount of barley was grown on this type of land before the introduction of the shorter-strawed Kenia and

Maja varieties, but these are now grown and have been known to give very heavy yields. With oats, as with other cereals, the difficulty is to keep the crop standing, and consequently strong-strawed varieties are used.

Latterly there has been a tendency for some farmers to develop the production of vegetable crops, and this departure from former practice is meeting with some success.

There has been a considerable reduction in the numbers of livestock in recent years, and an increasing reliance upon fertilizers as a means of growing good crops. Even the use of short leys has decreased, although this has been offset to some extent by peas. As these soils are inherently fertile, one can take liberties with them over long periods. Many fields have been cropped and fertilized in recent years in ways which would not have been approved by some of our more orthodox ancestors, but no harmful effects (in terms of yields, at any rate) have so far become apparent ; in fact some farmers say that potatoes have given bigger crops without foldyard manure, but other factors may have had a bearing on this. At the same time it will, in the long run, be desirable to devote a larger acreage to short leys and other means of maintaining soil organic matter, including keeping a larger head of livestock generally.

The economics of beef production have, of course, affected the livestock position, and particularly the difficulty of obtaining good stores at a figure which will not leave a heavy loss on the finished product. A few farmers have endeavoured to meet the difficulty of supplying stores by themselves, rearing suitable beef-type calves by multiple suckling or otherwise, and one or two have switched to rearing dairy heifers as possibly a more profitable alternative.

In 1947 much of this district was seriously affected by flooding, in common with many low-lying areas. It was a depressing sight in the spring of that year to see hundreds of acres of our best farmland inundated when normally crops would have been in. This spring the outlook was quite different ; the land was in good condition, crops went in early and, generally speaking, prospects are very much better.

What of the Future ? As stated earlier, very little warping is at present being carried out. Our forefathers found it worth while to do so. Whether, in fact, with the world food scarcity confronting us, it will again become economic for us to do so one would be bold to prophesy. We have facilities at our disposal in the way of machines and power for the construction of embankments and waterways not available to our fathers, and it may be that sooner or later we shall decide that it would be to our advantage again to develop warping. However that may be, in the meantime our existing warp land will no doubt continue to be farmed at a high level of productivity and continue to make a substantial contribution to our national food supplies.

FARMING IN THE NORTH RIDING

D. S. HENDRIE, B.SC. (HONS.), N.D.A., N.D.D.
County Agricultural Officer, Yorks, North Riding

THE North Riding of Yorkshire is the third largest county in England and Wales. It stretches from the tips of the Pennines at Mickle Fell and Garsdale to Redcar, Whitby and Scarborough on the North Sea and, southwards, from the Tees to the Upper Ouse and the Derwent. Perhaps it comes about as near to earning the description "unspoiled" as any county in England. The two large towns which draw so much of its business and are frequented by so many of its farmers—York and Darlington—lie outside its boundaries, and within it only the County Borough of Middlesbrough and Scarborough make any serious pretension to the title of city.

The strip of Tees-side industrial development from Thornaby to South Bank alone encroaches hungrily on farming land; otherwise the picture is of agriculture into which a score or so of small market towns and a host of charming villages blend to perfection. A strong feature is the nearness of so many of the people to the soil, and the natural and intimate way in which the weather, the state of the crops, stock, and all those other things that really matter to the countryman, figure in everyday conversation.

Topographically, the North Riding consists of the western dales (in which snuggle the Tees, the Swale, the Ure, and their small tributaries), the northern part of the Plain of York, Cleveland, the North Yorkshire Moors, the valleys of the Derwent and the Rye and the dales which run northwards from them.

The rainfall varies from 60 to 80 inches in the high Pennines to 20 inches in parts of the Vale of York. Much of the higher land is bleak and windswept. The coastal belt suffers from late springs and cold north-east winds which often bring with them a persistent sea mist. Spring frosts are common in all parts, and so limit the areas where fruit and early potatoes can be grown.

Small Mixed Farms The county is essentially one of small farms—usually family farms. The latest agricultural returns reveal about 10,500 farmers, of whom only 30 or so have more than 500 acres and 7,000 have less than 100 acres. The number of regular workers employed does not quite average one per farm. Farming is, therefore, more than ordinarily a way of life as well as a business, and there is still an active tradition of craftsmanship. Livestock are of basic importance. The typical farm is a small enterprise going in for mixed production—some cash and fodder crops, milk, a pig or two, poultry, and calf rearing. In these times of assured markets production would probably benefit from a little more specialization, for he is a clever man who can master the scientific technique of more than a very limited number of branches of production.

Collectively, this pattern adds up on recent figures to 230,000 acres of corn, 30,000 acres of potatoes, 9,500 acres of sugar beet, 41,000 acres of roots, 10,000 acres of fallow, 88,000 acres of temporary grass, and 354,000 acres of permanent grass. The acreage of permanent meadow has been reduced from 157,000 pre-war to 95,000 acres, but the low yields typical of this type of grass indicate that this large acreage is probably one of the weakest spots in the field of production and that ploughing-out should not yet come to a full stop.

On the horticultural side the figures show some 2,500 acres of vegetables, of which an increasing proportion is grown on ordinary farms. There are less than 100 acres of soft fruit, perhaps 55,000 fruit trees and about 900,000

sq. feet of glass. The horticultural industry is, therefore, comparatively small, and market gardens, as such, are usually small units.

In livestock production, milk predominates. Probably about 150,000 of the total head of 230,000 cattle are dairy animals in milk or intended for milk production: 90,000 are either in milk or in calf, and some 6,000 farmers sell milk. Pigs are not kept extensively and numbers are, of course, now much reduced. Ewes and shearling ewes numbered 305,000 before last year's blizzards and, as elsewhere, the number of lowland sheep has fallen. The arable sheepfold has almost disappeared and the leys are not so far compensating for this loss. Poultry stock is now under 1,500,000, and intensive poultry-keeping has few adherents.

Hill Sheep and Cattle There are about a thousand farmers who qualify for the hill sheep subsidy who may be described as true hill men. Hill sheep are, of course, kept on a wide range of farms from almost lowland to true hill conditions. Over 800 feet the hill sheep farm is recognizable by breeding at least a proportion of pure stock for replacement. Amenities as known to the townsman are for the most part non-existent, and it is a never-ending struggle to retain enough of each generation to enable the essential work to be carried on. Most of the farms consist of some enclosed land (often running down to a much lower level) together with sheep rights on the moors. The farms are smaller (the average is less than 100 ewes) and the life is not of the spacious kind ascribed to the Borders. The husbandry is less formal and in many cases the system of maintaining and disposing of the flock would appear rather haphazard to the northern flockmaster. Nevertheless perhaps 350,000 sheep and lambs summer on these farms and are an essential part of the farming of the county. The snowstorms of 1947 were a major catastrophe. In June, 1947, the hill sheep stocks were down by 30 per cent on the previous year (lambs by 45 per cent), and it will take many years before the flocks are at full strength again. The North Yorkshire moors recorded sheep losses as high as 51 per cent.

The milk churn tends to appear in the most unlikely places, milk being sold from some of the highest and most inaccessible of the farms. Most of the cattle reared are dairy replacements, and bull calves are even less popular than in the low country. The number of cows being kept has increased the consumption of hay in such areas to a level which the limited area of meadow land cannot supply. Some recent figures suggest that at least £60,000 worth of hay has to be imported each winter to close the gap. This fact gives a simple objective in the expansion programme for such farms, i.e., to increase the productivity of the grassland.

Dairying The dairy farm is not, on the whole, well defined. There are a few intensive dairy farms keeping Dairy Shorthorns, Friesians or Ayrshires, bending all their energy towards filling the churn, and pressing on to the 1,000-gallon mark and beyond. For the most part, however, milk production is part of the mixed farm enterprise. The average is probably 10 to 15 cows of the Shorthorn type. It does not single out the North Riding from most other counties to say that there is still much room for improvement in the production of milk from such farms. In the past the objective has been too indeterminate, and the choice of bull too haphazard. There is, however, a rapidly growing tendency to use artificial insemination where the service is available, to record milk, to aim at self-contained herds and, although slowly, to aspire to attestation. There will always be mixed areas in the county where milk will be only one of the sale

products and where the rearing of store cattle will require methods not differing greatly from the traditional dual-purpose system.

Long Arable Tradition The arable tradition is strong over most of the Riding and, of course, the county did not suffer an upheaval during the war comparable with that in those counties which had to change from all-grass to a substantial proportion of arable. In the Vale of York there are a considerable number of the larger (200-400 acres) farms growing potatoes, sugar beet and, on the lighter land, carrots. The livestock policy is one of rearing and/or feeding, and mechanization is fairly well advanced. There are some 80 combines, 30 grain driers on farms, 80 crawler tractors of the higher-powered type, 12 sugar-beet harvesters, and 30 pick-up balers in the county. On such farms and on smaller farms of the same type, are grown about 90 per cent of the farm vegetables, half of the potatoes and three-quarters of the sugar beet. The other most clearly-defined arable type of farm is on the heavier clays of the northern part of the county, where wheat and bare fallow play their traditional parts. This is the kind of land that produces ploughing champions.

Looking back over the war years, the county can justly take pride in a job well done. Up to March, 1948, about 250,000 acres of grass were ploughed out for cropping and direct reseeding. By 1944, the tillage area had increased by about 70 per cent. Potatoes increased from less than 12,000 acres in 1939 to 30,000 in 1946, and even more is being grown this year. The vegetable area increased sixfold. Barley and wheat together increased from 88,000 acres in 1939 to 175,000 in 1944. The cattle population actually increased during the same period and this is true also of the quantity of milk sold off farms. The swing-over to winter milk production had as a sequel the award of a Victory Churn in 1942–43 for the biggest increase in winter milk production in the Northern Area.

There is no North Riding County Show, but there are a score of smaller shows which vary from a purely local afternoon event to the magnificence of Stokesley at which, so it is said, even Royal Show exhibitors have heaved a sigh of relief when their national leadership of a month or two before has not suffered eclipse !

SPRING IN THE DALES

JEAN M. THORNBORROW

Arkengarthdale, Richmond, Yorks

THERE is a nip in the air, and the skylark is singing sweetly high above me this spring morning, as I take my stick and box (containing ear-markers, marking materials and lambing oils), whistle my dog, Floss, and set off on my first round.

I start with an inspection of the home pastures, where the shearling ewes and two of the four flocks from the moor are kept until they lamb, to enable me to keep a close watch over them, especially the shearlings during this critical period of first lambing. The older ewes must be guarded against "moss illness" or "staggers". At the first sign of this terrible malady

I must either treat the affected animal on the spot or bring the ewe (and its lamb) back to the farm for an injection. It is then that I conform to the townsman's idea of the shepherd, as, with the lamb nestling snugly in my arm, and the ewe following sedately behind (I hope !), I make my way back with Floss bringing up the rear—in case the ewe won't follow. Once home, immediate attention must be given, for a few hours' delay would prove fatal.

A number of lambs have already been delivered this last week or so, and these are scampering around evidently very pleased with life. Very soon now they will be marked and driven off to the moors with their mothers.

Circling the pasture I find several new-born lambs. The ewes are really very wise, not silly and stupid as most people think, for they usually choose to lamb near the dry stone walls which will provide shelter for themselves and their lambs.

As I move around the field, Floss keeps close behind me until she is needed (as every good dog should), so as not to disturb and frighten the sheep. I note that all the sheep have their lambs and that they are well.

Each new lamb is examined closely, a mental note being made of its markings and sex. I also make sure that it has taken the ewe's milk or appears as if it will do so, and that the mother shows no inclination to desert her offspring. If a ewe loses her lamb at birth or soon after, we take a twin lamb from its mother and give it to the other ewe. To do this we skin the dead lamb and put the skin on the live one until the ewe, deceived by the smell, claims it for her own. The skin can then safely be removed.

Most of the morning is spent in this way, and after helping with the housework and the midday meal, I set off again to visit the ewes and lambs in the pasture, and then up to the moor to help my father.

Our moorland extends over some 1,400 acres, and the sheep are divided into four flocks and marked accordingly. On this open moorland the sheep can wander for miles, which means that we have to walk a long way and make sure that we do not miss any ewes that may be ill or perhaps in lambing difficulty. There are, of course, occasional casualties, and one must always keep a sharp lookout for lambs which have strayed from their mothers and for any that may be missing, perhaps trapped or fallen down one of the old mine workings, or maybe killed by traffic on the road. It is in these instances, among many others, that an intelligent and well-trained dog is indispensable—particularly for drawing out the mother ewe to accompany a sick or injured lamb back to the farm.

Towards dusk I make another round of the pastures. Then with dusk closing in, the cry of the curlew overhead and the swish of grouse through the rushes, I pause to look round our beautiful dales. I cannot help thinking how lucky I am to be able to live in such a lovely part of England. I look down upon the peaceful valley below, with the River Arkle dancing gaily away to join the Swale. Then my gaze wanders over to the left where in the distance I can see the verdant valley of the Tees, and the white-washed farmhouses of Teesdale. In the foreground Barnard Castle stands proudly against its background of trees, with the well-known "Bowes Museum" a sentinel to the old market town.

I turn for home with Floss at heel, both healthily tired but looking forward to tomorrow.

The Swaledale A word on the Swaledale. It is a medium-sized sheep and very hardy and thrifty. The head should be of medium length, strong in feature, with a tuft of wool on the forehead. The upper part of the face is black and it should have a white nose end.

The eyes are quick and bright, the hair on the face short and strong. This type of sheep grows grey with age. The horns should be uniform and low set, round and rather wide. The wool should be white (except at the back of the head where it is mixed with part black) with a thick, deep bed and curly top, medium length, not coarse, and which hangs well down the shanks. The wool has a good bind and fills the hand well. The neck should be of medium length, shoulders medium and well-rounded ribs, chest well let down, broad level back, good firm loins, long drawn hind-quarters and full in thigh. It should have a long, thick, white and woolly tail, the legs good flat bone of medium length, well set, and with well-shaped hocks, grey, or mottled black and white and with good-sized feet. It should walk well with its head up.

The Swaledale sheep has proved itself to be a bold, hardy sheep, well fitted to endure the hardships of exposed and high-lying situations. It is of an alert nature and a good thriver. The ewes make excellent mothers. After the dales people sell them, they go to cross with the Wensleydale ram, thus producing the Masham half-bred.

The wool from the Swaledale sheep is admitted to be most durable in wear and of an even texture. Being excellent feeders and of strong constitution, as mutton producers they stand second to none.

Besides our flock of registered Swaledale sheep, we keep about 30 head of cattle (Dairy Shorthorns). My brother and I also have a good pen of pure Rhode Island hens from which we breed and sell the chicks each season.

A Young Farmer My leisure time is spent at the local Women's Institute, of which I am a committee member. I am also a member of Reeth Young Farmers' Club, the vice-chairman to be exact. This club is the oldest and largest in Swaledale and is very active. During the winter we compete with other clubs in quizes, and knowledge bees, and in the summer we have judging competitions. This year we are holding our annual dales club rally at Reeth, in which about ten dales clubs will take part. There will be judging, sheep shearing, fell-racing, sports, and sheep dog trials, for the young farmers. The members of our club come from the hills around, and many of them have to travel up to seven miles to the meetings. Recently the Club invited Wilfred Pickles to come to Reeth and along with other dales folk, we took part in a *Have a Go* programme. I was fortunate enough to be selected as one of Wilfred's "victims" !

Of course, we have our dances too, and up here we prefer the real, old-time dances, such as the lancers and the maxina.

Two years ago I went with about a hundred other Young Farmers from the North Riding to London and attended the Annual General Meeting of the National Federation. It was very interesting to meet young people from all over the country and exchange our views. I hope to go again this year.

We hold a very good agricultural show at Reeth on September 1 and, of course, there is a lot of friendly rivalry between the dales farmers.

The sheep sale which we attend is at Barnard Castle, to which we have to walk our sheep about 10 miles. During the past eight years we have taken six first prizes for the best pen and we hope to do so again this year.

I really enjoy my shepherding and, although I do not suggest that in a general way women can replace men in this capacity, I think that if they are born to hill farming and have a natural liking for outdoor work, and real interest and understanding of animals, they can do the job equally well. I also like shearing sheep.

SPRING IN THE DALES

Here, in the dales, I find an undying interest all the year round, but I have a special affection for the spring—

> . . . when the scene is changing every day
> And new beauties burst upon our sight.
> Colours deepen in the sunshine and the rain.
> A miracle is happening ; the world is being born again.

DAIRY FARMING IN THE WEST RIDING

W. Harwood Long, M.A. and J. D. Sykes, N.D.A.
University of Leeds

THE West Riding, the largest of the three Ridings of Yorkshire, encloses an area of 2,775 square miles and is populated by 3½ million people. Industrially, it is world famous, but many acres still remain to provide some of the food for one of the largest groups of consumers in the British Isles.

Broadly speaking, there are three types of dairy farming in the Riding :

1. Arable and mixed farms with considerable dairying.
2. Dales farms.
3. Dairy farms in industrial areas.

The Pennines reach practically half-way across the Riding from the Lancashire border in the west to a line running southwards from Ripon through Leeds to Sheffield. The western half of the Riding is therefore an area of high land intersected by many dales. Farms are found on the hill-sides ; the towns and factories are mostly situated in the bottom of the valleys.

To the east of the Pennines, enjoying conditions more favourable for arable crops, with a rainfall of 25 to 35 inches, is the Vale of York.

Dairying on Arable and Mixed Farms Dairying was introduced to many of these farms during the depression between the wars. Many difficulties have had to be overcome ; water supplies are not always good, not all fences are stockproof, and buildings are frequently unsatisfactory for milk production. Nevertheless, despite handicaps, assured markets and the provision of transport have brought these farms into the milk market.

Most dairy farmers in the arable areas are wholesalers. They are able to produce all the food required for their stock, though they usually purchase their quota of concentrates. Many of them rely on cash crops for half or more of their farm income. The dairy stock provide muck for these crops, and cows are now wintered in the foldyards where bullocks were once fattened. Although many farmers breed and rear their own replacements, a number buy third-and fourth-calved cows which have been previously milked in the industrial areas and summered in the dales. These animals

are usually of a mixed type and include Shorthorn-Ayrshire crosses. There appear to be rather more Friesian stock in the arable area than in the dales. Some self-maintained herds have been able to gain T.T. and attested licences, but besides the usual handicaps under which small farms labour in improving their herds, difficulties are experienced where water supplies and buildings are inadequate or unsuitable.

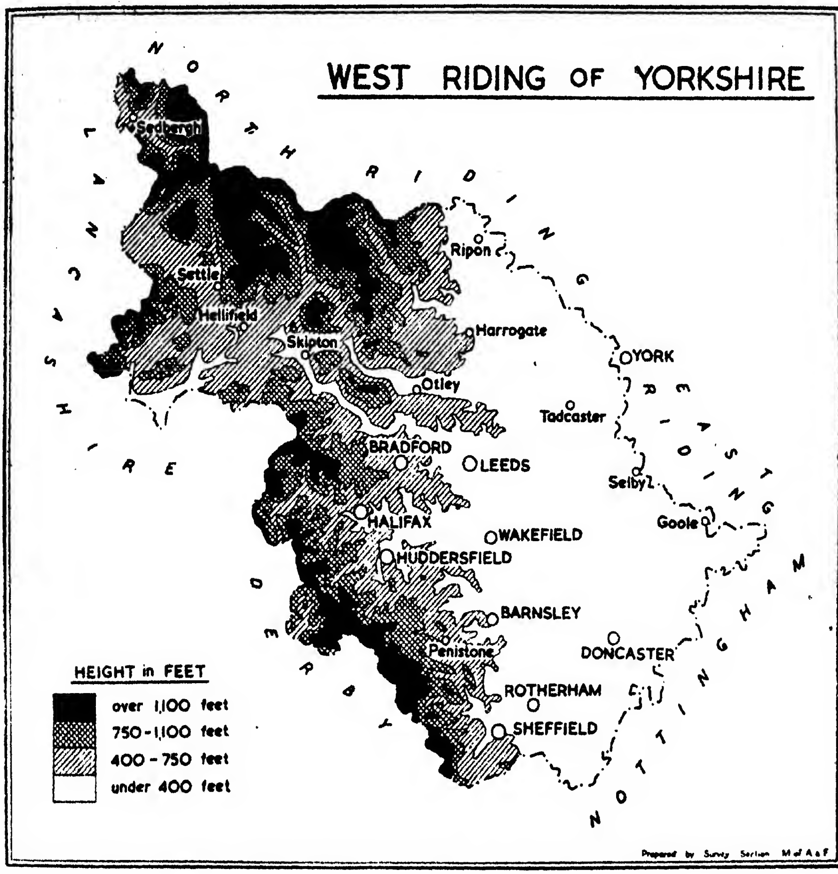
The following brief description of the organization of two arable dairy farms will indicate the main features of dairy farming in this area. The first is a farm of rather less than 200 acres, of which 43 acres are under grass. Eighteen T.T. commercial Ayrshires are milked by machine, and the average herd yield is just over 700 gallons, with 16 per cent of cows dry throughout the year. The farmer produces all his own stock foods, and for the winter of 1947-48 the following fodder crops were grown: oats 17 acres, mixed corn 13, roots 10, seeds hay 21. Not all the fodder crops grown were fed and a proportion of the roots was sold to farms in the Halifax area. The milk is sold wholesale and is taken by road to York. The farmer relies for his income on corn, milk and newly calved cows.

Another arable area dairy farm is situated on the coal measures on the edge of an industrial area, about 10 miles from Wakefield. The farm is 150 acres in extent and is close to a mining village. Twenty-four cows are milked by machine, and the farmer has been a wholesale producer for many years. The milk is sold by a retailer in the neighbouring villages. Only concentrates are purchased, and for the winter of 1947-48 the farmer grew the following fodder crops: oats 30 acres (part of the crop was sold), peas 3, roots 7, seeds hay 8, meadow hay 13. His chief sale products are milk, corn, and potatoes. Up to the present most replacements on this farm have been bought in, but to reduce the spread in price between the cows purchased and sold, most of them are kept for only one or two lactations. During 1947, 10 cows were sold for profit and only 2 were sold fat. The stock are of a mixed type and the herd average for 1946-47 was 638 gallons, with 20 per cent of the herd dry.

Dales Farms The dales farms are situated mainly in the many dales to the north-west of the Riding. Because of the underlying limestone many of the hills have a characteristic rounded form. Some dales, however, are on the millstone grit; this rock occupies a very large area in the Riding. The limestone provides sweet and nutritious grass, but the grass of the millstone grit is on poor, lime-deficient soil and compares unfavourably with that on the limestone. Rainfall in the dales is high—almost double that of the arable districts and with the rich alluvial soil in the valleys produces abundant grass. Many dales farms are unable to winter sufficient stock of their own to eat the summer grass, and they buy dry in-calf cows early in summer from the industrial areas. The underlying limestone enables these cows, which have spent the winter indoors, to regain condition rapidly, and they are sold again to the industrial areas in the autumn.

Until road transport opened up the dales, many were rearing areas and any milk produced was made into butter or cheese. Sales of newly calved cows have always been an important source of income, and sheep were, and still are, a vital part of the farm economy.

Many dales farmers rear heifer calves or purchase store heifers some of which come from Ireland and Scotland; they bull them and sell them as first or second calvers at Hellifield, Otley and Skipton, to farmers and dealers. Many first and second calvers go to the industrial districts, where they are milked until dry; if in calf they then return to the dales. These in-calf cows



are summered and receive no hand feeding until springing, when they get a little cake(¹) : some third and fourth calvers go to the arable dairy farms in the Vale of York and to Doncaster, Penistone and Sheffield. Some of the Ayrshire types coming from Scotland return there as third and fourth calvers. Others are sold into the industrial dairying areas of Lancashire.

Milk selling came to the dales in the early 'thirties, when the trade for newly-calved cows was bad. Transport then became available for the first time to take the milk to Leeds, where town dairies had previously been common and much milk is consumed. As about 50 per cent of the available land surrounding Leeds is occupied with market gardens and rhubarb growing, the producer-retailers so common near other industrial towns have never been numerous in Leeds(²). This encouraged the dales to exploit the Leeds market as soon as transport costs allowed.

Despite the advantages which abundant grass gives to the dales dairy farmer, the problem still arises of providing enough keep to produce milk during the long winter period, which may extend from October well into May. Although good crops of certain cereals can be grown, difficulties are experienced in harvesting them. Similarly haymaking is risky, and often the grass is cut late that it can be got more easily.

Farm buildings in the dales are substantial; they are built from the local stone. Frequently they consist of a barn in which the hay is stored; cow standings are situated at one end, with hay in the loft above. Nearly all the

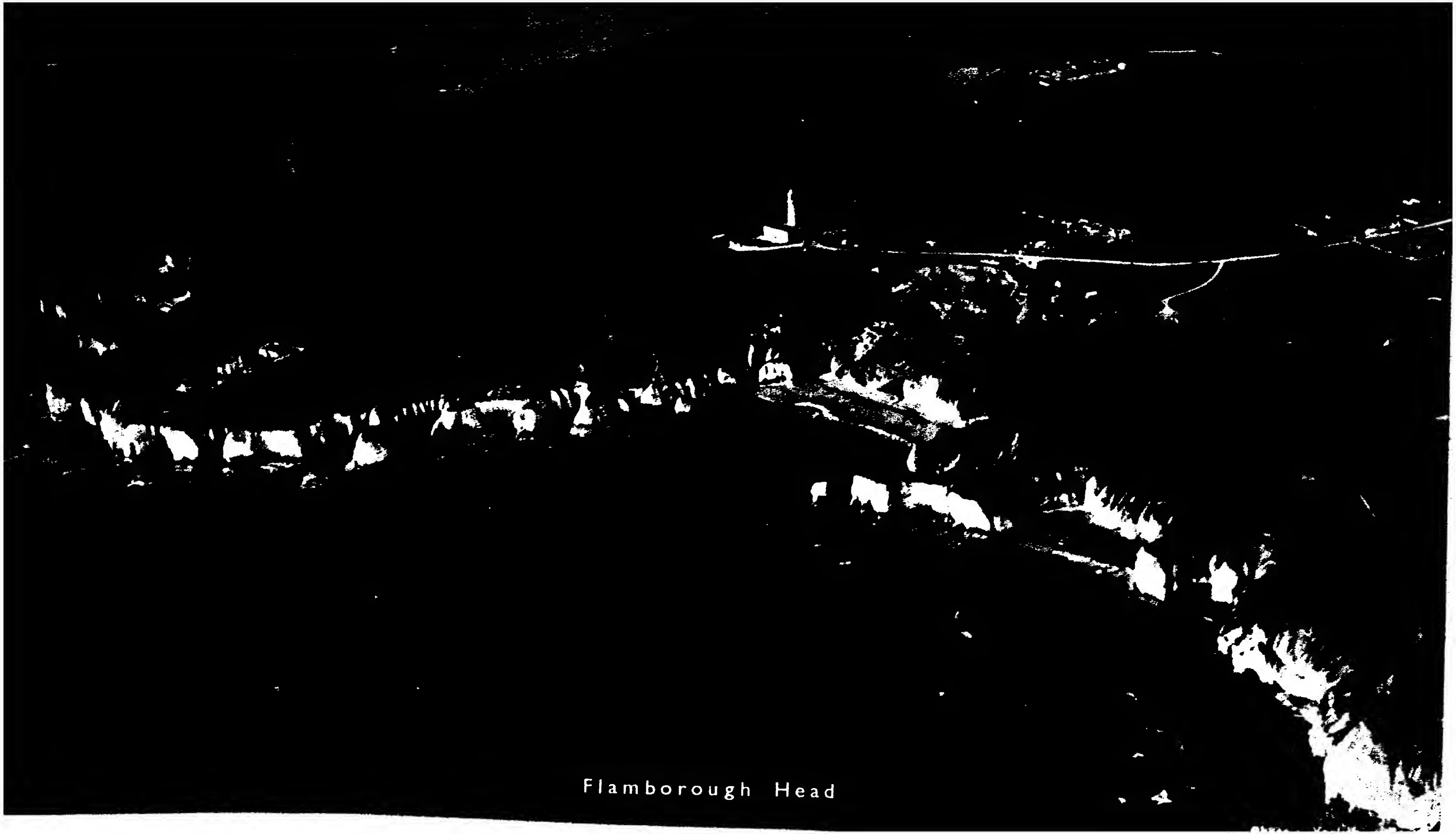
hay comes from meadows, which receive all the dung apart from that which goes on to the small acreage of arable.

A farm of about 170 acres near Settle illustrates wholesale milk production in Craven. Until road transport came to take the milk away to an industrial area, the farm income depended upon the sale of newly calved cows, a few fat animals and stores and, to a large degree, sheep. Sheep are still important, and a flock of Swaledale ewes are crossed with a Wensleydale ram. A herd of 16 attested Ayrshires is milked by machine in a newly built shippon. At a height of about 700 feet is a field barn where dry cows and yearlings are wintered on hay produced on the high land. The sheep run on rough moorland at a greater height. Good arable crops have been grown but have not been well harvested owing to the nature of the land and the weather. All the hay is cut from the meadow in July. Because the farmer has concentrated on T.T. milk production, the newly calved cow trade is of little importance to him.

On a farm of 80 acres, a neighbour also produces wholesale milk, but in addition deals in newly calved cows. In April, 1947, 18 dry in-calf cows were purchased at an average price of £47, and 18 were sold newly calved in August and September at an average price of £53. This farmer has reseeded about 30 acres of land and runs a flock of 60 ewes ; sheep are the second most important sale product. Because of the high numbers of dry cows—an average of 32 per cent for the whole year—the average yield for the herd of 23 cows was only 440 gallons. During the late summer months well over 50 per cent of the cows were dry.

Intensive Dairy Farms in Industrial Areas Practically all these farms are intensive smallholdings with high rents and markets close at hand. Before the war most of the farms produced milk, with poultry and eggs an important additional source of income. Many of them are found on the high parts of the millstone grit hills and the coal measures, but they are equally numerous in the urban districts where land has not been taken for building or industry. The land is subject to high rainfall and to smoke from nearby towns and mills. The most intensive concentration of dairy cows in the West Riding is on the high land, to the west of the industrial district of Halifax and Huddersfield ; second to it is the area between Skipton and Bradford([3]).

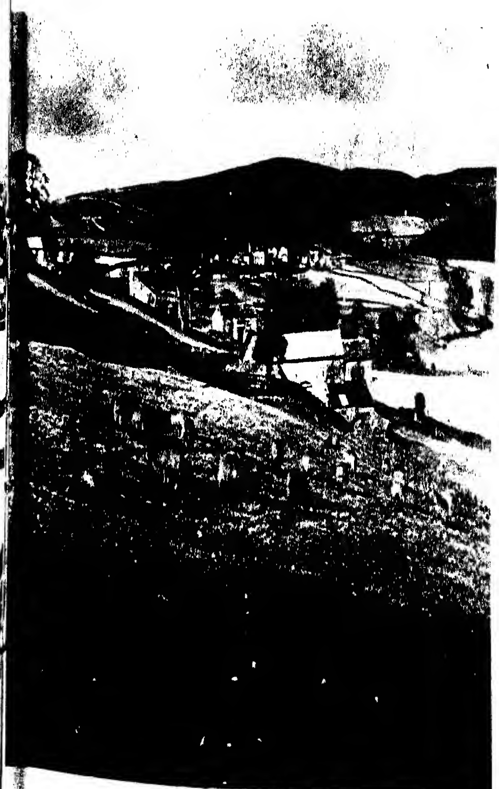
Halifax and Huddersfield form a great retail milk market for the small farms clustered on the many nearby smallholdings. These smallholdings form part of a system which probably has no parallel in Great Britain. The farms are chiefly under 40 acres, and the majority are located on the steep sides of the valley above the valley towns. Their elevations range from 400 to 1,100 feet, with the greatest number about 600-900 feet([4]). The farms are heavily stocked with in-milk cows (about 2 acres per cow) but few other animals are kept. Until the beginning of the war there was no arable land and the cows used the poor grassland mainly for exercise ; in addition to rather poor quality hay, they consumed large quantities of purchased concentrates. Since 1939 land which could be ploughed has been sown with oats and swedes, but on the whole the crops have not been good. Fields are small and are enclosed by stone walls which were often built to utilize the stones left when the land was cleared. The farm buildings, like those of the dales, are substantial and have a combined barn and " mistal". The farmhouses built at the same time are of considerable antiquity, and most of them date from the earlier half of the seventeenth century. The buildings were constructed by yeomen farmers who, in addition to providing food for the family, wove pieces of cloth at home.


Flamborough Head

The Wolds

Magnesian limestone, where the folded flock on roots is still seen

The Dales



Photos. H. I. Moore

WEST RIDING

Photo, H. I. Moore

Typical West Riding country. Note the small fields and stone walls.

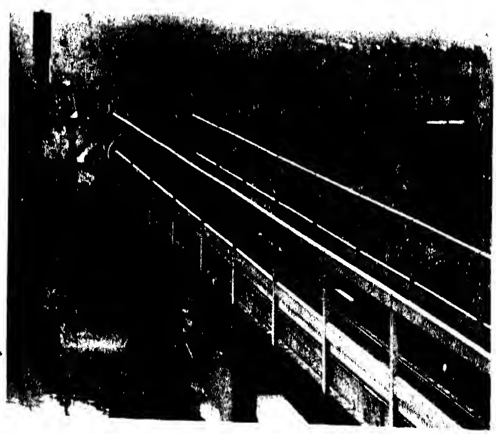
Photo, H. I. Moore

Milk production on the fringe of the industrial area.

WARPLAND

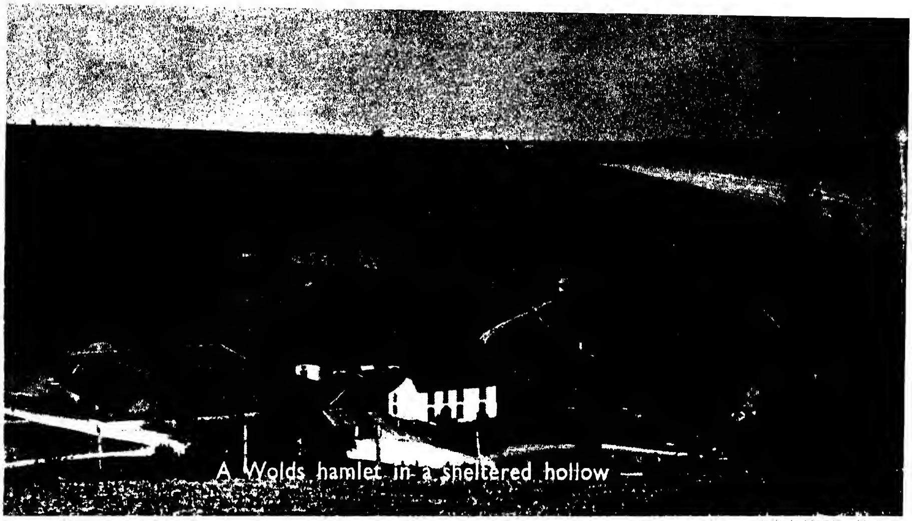
Photo, W. W. Gatenby

Land flooded with tidal water during warping. When the tide recedes the water flows off, leaving behind a thin deposit of warp.

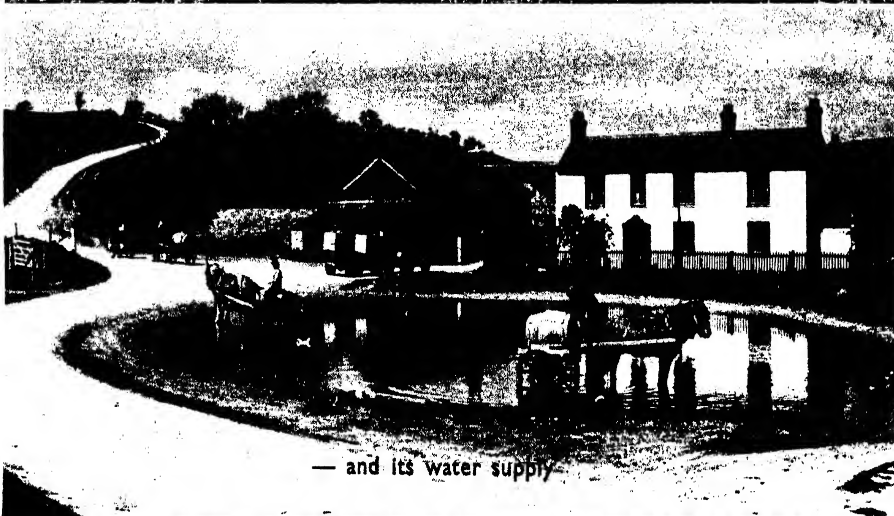


Photo, W. W. Gatenby

Land where warping has been completed and the natural vegetation allowed to develop. Note the grazing cattle on the right. The warping drain (at low tide) may be seen in the foreground.



A Wolds hamlet in a sheltered hollow —

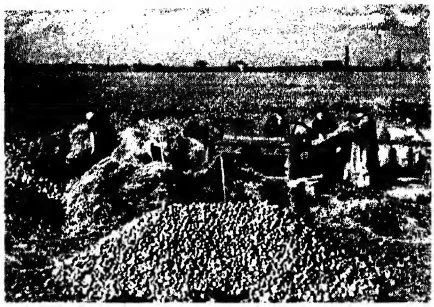


— and its water supply

Preparation for a drilling of roots in a large Wolds field

Photos: W. W. Gatenby

Oat harvest on the Wolds, near Driffield.



Photos. *Yorkshire Post*

Potatoes, near S. Milford.

Sugar beet, near Snaith.

Photos. *Yorkshire Post*

Photo. *H. I. Moore*

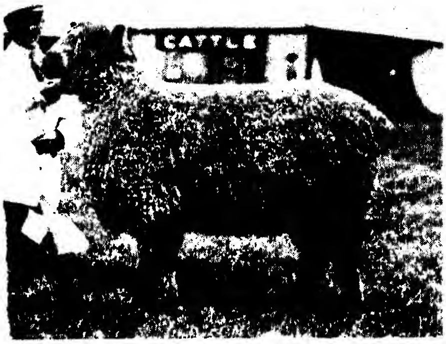
Photo. *Yorkshire Post*

Peas and Broccoli in the West Riding.

Outdoor rhubarb before taking into sheds for forcing.

Photos. *H. I. Moore*

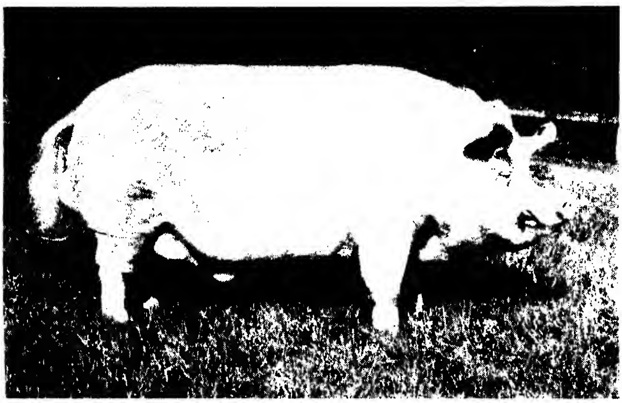
Dutch lights near Hull.



Photos. *Claude Hosegood*

Swaledale ewe *and* Wensleydale ram

Cross-breeding gives the Masham



Large White boar

(Large White are the most popular pig in Yorkshire, in which county it is said they originated.)

Photo. *Claude Hosegood*

A typical Cleveland Bay

(Deriving its name from the Vale of Cleveland, N. Yorks, the Cleveland Bay, a general utility breed of long service to mankind on the land, on the road, and in the field.)

Photo. *Cleveland Bay Horse Soc'y*

The industrialization of woollen manufacture created urban populations and handloom weaving on the farms died out. The farms turned eventually to producing—with purchased concentrates—milk and eggs for the market on their doorstep. As the system became intensive, cows were kept only during the time they were actually in milk, and replacements were purchased from the dales: thus the milk-and-feed system grew up, and cows were fattened during their lactation and sold for slaughter as soon as they became dry. The widening margin between the prices of freshly calved cows and fat cows shook the confidence of many farmers in this system, and led to their bulling their cows and selling them to be grazed by dales farmers during the summer. In this way the farming economies of both areas have become linked more closely.

The war disrupted production on these holdings and, with the reduced supply of imported concentrates, they have suffered more than most farms(5). It has been necessary by reason of the small acreage of arable land to purchase roots, hay and straw—and this at a time when market prices are high. The shortage of purchased concentrates also resulted in a big reduction in the numbers of poultry (6). Turnover was thus sadly diminished and a considerable degree of hardship was suffered in consequence. Those who have overcome these handicaps have done so mainly because they employ only family labour and because they have received the full retail price for their milk.

In addition to the dairy farms in the Halifax area, intensive dairying is carried on in other industrial areas—mainly further east. Here the land is less hilly and more attention can be paid to producing fodder crops, as the farms are larger and the system less intense.

An interesting example is that of a successful milk-and-feed farmer who farms between two industrial towns and sells his milk wholesale. He rents about 50 acres, of which only 5 are under the plough. He milks nearly 30 cows and turns over every cow in the herd each year. The buying-in price is about £46 each, and the price made for the fat and barren cows when they leave the farm is £22-£26. The cost of herd replacement is thus considerable but the value of the milk sold averages about £100 per cow. His labour staff consists of two men besides himself and his wife. Another big expense is purchased foods, including nearly £200 spent on roots in some years. However, the total expenditure on hired labour and bought foods represents only half of his gross income per cow, and after deducting all other expenses he is normally left with a profit, which must be considered satisfactory taking into consideration the size of the farm.

References

1, 2, 3. Miller, T. E. Economic Survey of Agriculture in Airedale and the Calder Valley. *Unpublished thesis in the Agricultural Library, University of Leeds.*

4, 5, 6. Davies, G. M. Farming in an Industrial Area. *Farmers' Report* (1944), *No. 51, University of Leeds.*

A WEST RIDING FARM

EDGAR GREENWOOD
Poplars Farm, Bradford

Poplars Farm is 100 acres, lying on a steep hillside rising from the city of Bradford. It is in a built-up area, surrounded by mills and houses, and the soil on the millstone grit is naturally acid, apart from sooty deposits. In addition, Mr. Greenwood has 100 acres of accommodation land adjoining, and a hill farm of 206 acres on Ilkley Moor. Before the war, when Mr. Greenwood only had Poplars Farm, he bought in his dairy cattle from local markets and was purchasing for them 20 tons of concentrates a month. Mr Greenwood still keeps a dairy of 112 T.T. cows, and has recently started a pedigree Ayrshire herd. He began farming with six cows when he was demobilized from the Army in 1921, and has been through all the struggles of a producer-retailer.

LOOKING back over twenty-seven years of farming in the industrial area of the West Riding, I wonder sometimes how we managed to make a success of it. I remember that fortnight in April, 1923, when twenty of my twenty-five cows aborted two to three months before they were due to calve ; the night when I awoke suddenly to see my farm buildings ablaze ; my feelings when, in 1928, we first had our cows tuberculin tested, and all except two of the fifty-two reacted. I remember also, all too vividly, those minutes which seemed like hours when our old bull had me down in his loose box.

But on the other side of the medal, I recall our keen joy when we won the county clean milk competition in 1929. What excitement there was, too, when we were first given our attestation licence in 1938. Such things, the luck—good and ill—are the very stuff of farming life and the common experience of us all.

* * *

Today, May 8, we have been safeguarding our protein needs for next winter's milk production ; in other words, we have been making grass silage. There is grass everywhere this first week in May—but I'm afraid we don't all make the best use of this high-protein stock feed—and it is high-protein food only when it is caught young and leafy. More has been written about silage-making in farming journals during the past six months than I ever remember seeing before. Many advocate the pit silo instead of the tower, but it is my opinion that if a farmer cannot make good silage in a tower silo, he will not be any more successful with a pit ; he will make the same mistakes. I have made high-protein silage for the past ten years. The rules are quite simple.

Consider first of all what you do when you are bottling fruit, say, gooseberries. You use the young, small berries. Thus for silage you use *young* grass (not more than 4 inches high). Similarly, since you would never use a cracked bottle for your fruit, see to it that the silo, whether tower or pit, is airtight. Then watch carefully to ensure that the silo doesn't start steaming. A steaming silo is not making silage ; it is making muck. You can stop the steaming by adding more grass, or, if the grass is all in, seal carefully by laying on the top of the grass some old bags with a good thickness of heavy, close material.

Usually it is getting the grass from the field to the silo that is the big problem, and has perhaps deterred a lot of farmers from making silage. There are, I know, many different ways of lifting the crop. At Poplars Farm we mow early (while the crop is wet) what we are likely to move in one day, then lift it by pick-up. All the labour we use for silage-making now is the tractor-driver and his mate, and the work is not very hard.

* * *

The management of grassland is one of our most important jobs. Grass should be grown as a *crop*. One acre of pasture should feed a cow during summer and one acre of grass made into silage or hay for the winter. During the past twenty years we have gone through the gamut of pitchpoling, drastic harrowing of matted pastures and, for the last ten years, ploughing and reseeding.

After ploughing out grass I like to take a couple of white crops and then a crop of greens, say, cabbage or kale. In the fourth year, after a good liming and dressing with phosphate and potash, we seed the field down again without a cover crop. This is ready for grazing five to six weeks after sowing, and we graze it well right through the summer, to give a full bottom and discourage weed growth. In the following October, a light dressing of farmyard manure ensures that the field will be ready for early bite, silage-making in May, or haying in the first part of June.

For the third year the field is usually shut up for hay. The full life of the field is determined by its condition and not by the length of time it has been down. Some of my fields have still been very productive after seven or even eight years; others have lasted only a couple of years.

The treading needed to make a first-class grass field we sometimes secure by first sowing rye on old arable in October. This is grazed off in March and then reseeded. But a careful watch must be kept on the rye to see that it does not run away. Stock must graze it every day.

* * *

Another crop that we grow is beans—the most useful of all, I consider, on a dairy farm. Bean meal is rich in protein and is a milk producer of the first order. True, beans are difficult to crop in this part of the country, for unless dusted, black fly normally takes a heavy toll when the plant begins to flower.

A plentiful supply of swedes and mangolds is also grown.

* * *

I was at a sale of attested cattle the other day and was particularly interested in the horned and dehorned Ayrshire heifers. As I expected the horned animals fetched half as much again as the dehorned. This is because in the West Riding and East Lancashire all cattle down to small calves are tied by the neck. For at least half their lives they are chained up because very little bedding material is available; in many parts neither wheat nor barley is grown, and all oat straw is fed to the cattle. A dehorned beast cannot be held fast by the neck, even when a leather strap replaces the chain; the animal gets into the habit of wriggling out of it, and although dehorning may be all right in foldyards and open courts, it is never likely to be adopted widely in the Pennines. Breeders of dairy cows for sale should give this matter serious thought.

The foldyard or corn-growing men will soon desert from the ranks of the milk producers if we should hit a phase of over-production, and then where would you be with your dehorned cattle? The hillside milk farmer will not want them, although he is forced to stay in the business even in bad times because his farm cannot be used for anything else but milk production.

* * *

Looking at my last autumn's crop of heifer calves, I bless the day when I put quite a bit of money into a really good bull. This is the third crop of calves from him, and some of his daughters are already in the milk herd and are certainly better beasts than their dams. A bull is said to be half the herd. If he is a bad sire he will be *all* the herd, as the poor qualities will show up in every one of his progeny.

* * *

The hot weather will be here shortly and people will be grumbling about sour milk. Living near a large city I meet many people in the course of a year, and I am astounded to hear of milk going sour as soon as it is delivered. No doubt much of it is older than it should be, and in some instances it may have been put through the pasteurizer more than once. I am certain that many farmers could produce cleaner milk than they do. Some farmers believe that a really good milk strainer and a change of wads every 10 gallons or so will give them clean milk. Others install a steam sterilizer but forget to use it.

In my experience there are four simple rules for clean milk production—tuberculin tested cows, clean and sterile utensils, properly washed udders, and efficient cooling. Some day milk may be paid for on its keeping qualities, and then perhaps my town friends will be able to have sweet milk in hot weather.

* * *

Every spring, about the middle of May, I have had cows come into season that I had thought were already in calf. This kind of thing is very disappointing besides being very costly, since these cows are then getting to the end of their lactations. About Christmas time I had my vet examine those cows about which we had any doubt, and four of them believed to be in calf were found to be barren. They were accordingly run with the bull right through January, with the result that they are due to calve in November and will be in full production next winter instead of being passengers.

* * *

The labour problem is still with us, and nowhere is its effect more greatly felt than on the small mixed dairy farm. My own arrangements provide that each of the staff has a full day off every week. On some farms, I know that men arrive at 6.30 a.m., work until breakfast time, say nine o'clock, and are then given the rest of the day off. But I don't think this is really a good arrangement: a *whole* day off occasionally is much more attractive.

For some years, too, we have been running a sort of superannuation scheme. Men who have been with me for fifteen to twenty years now have a very useful endowment upon which they will be able to draw when they feel like easing off work a bit.

LIVESTOCK IN YORKSHIRE

K. N. Findlay, M.B.E.

National Agricultural Advisory Service, Yorks and Lancs Province

When considering the importance of livestock in Yorkshire it has to be remembered that the three Ridings spread from the East Coast to within a comparatively short distance of the West. This large stretch of country shows wide variation of soil and climate and so allows many forms of animal husbandry to be practised successfully.

The Royal Show, which the ancient city of York welcomes this year to the Knavesmire, affords an opportunity to the Wold sheep breeders, to the dalesmen, to the dairy cattle breeders of the plains, to the graziers of the lowlands, to the stockmen of the hills, and to pig breeders all over the county

to show the world that production of the right types of stock is well within their power.

A farmer's choice of a livestock policy is naturally guided by topographical and other local factors, but in recent years great changes have resulted from economic pressure. A few can be mentioned briefly : the large incursion of the former rearer of dairy herd replacements into the liquid milk trade ; the establishment of black and white dairy cattle in the East Riding, where once the rearing of beef stores reigned more or less supreme ; the attractions of the cross-bred Ayrshire to the hill farmers on the eastern slopes of the Pennines, where the Dairy Shorthorn knew no rival and even the well-known flocks of sheep from the Wolds have given way before the lure of the monthly milk cheque. These changes in animal husbandry could not be expected to take place in just a few years, and naturally they give rise to many different problems. It is hoped that in time the transition will lead to constructive breeding.

The following figures taken from the June 4, 1947, returns clearly indicate the contribution that the livestock farmers of Yorkshire are making towards the maintenance of the nation's premier industry.

Livestock Population, June, 1947

	East Riding	No th Riding	West Riding	Total for Yorkshire	Total for England and Wales
Cattle	124,949	231,274	329,835	686,058	7,174,612
Sheep	261,763	472,848	435,536	1,170,147	10,161,132
Pigs	38,622	41,284	69,162	149,068	1,145,898
Horses	14,644	22,408	29,552	66,604	596,963

It would be invidious to select any particular breed of cattle as being better then another ; all have their uses. But since the Shorthorn, which embraces beef and dairy cattle, is numerically the strongest breed in Yorkshire, we will consider that first.

Shorthorns Under the auspices of the recently formed North-Eastern Branch of the Shorthorn Association there has been a revival of interest in one of our oldest and most widely spread breeds. The progress of the pure Beef Shorthorn has, through no fault of the breed, tended to flag on account of the encouragement now given to milk production. During the past twenty years there has been a tendency to go to extremes, either towards the small blocky type of beast on the one side or the heavy milker on the other. National policy now giving emphasis towards the production of beef stores will no doubt prove of much interest to these breeders. One of the objects of the Shorthorn Society Council is to promote the dual-purpose characteristics for which the breed gained fame in the past. The ability of the true Shorthorn to breed regularly, enjoy a long life, and produce a reasonable quantity of milk of good quality, is well known to Yorkshire farmers. Milk is not the only contribution which this breed can make to the national food supply ; calves from deep-framed parents not required for breeding can be relied upon to produce an economic carcass of beef.

The work of the Northern Dairy Shorthorn Breeders' Society is worthy of note. The dalesmen of Yorkshire have shown great interest in the activities of this comparatively new society which seeks to preserve and improve the distinctive types so much valued in their native surroundings. Membership has reached a high level, and regular sales are held at Leyburn and other places.

British Friesians The introduction of British Friesians into Yorkshire dates back to 1910 or thereabouts, and the popularity of this breed has grown rapidly, particularly in recent years. Facts obtained from the Yorkshire and Northern Counties British Friesian Breeders' Club show that there are now some 200 members in Yorkshire, and a brief study of National Milk Records (Yorks Branch) provides abundant evidence of the ability of this breed to maintain a good performance in spite of the so-called rigours of the north-east.

One method of assessing the progress of a breed in a county is to compare bull licensing figures : those for the East Riding show that in the year ended March 31, 1940, the number of Friesian bulls inspected was 19 per cent of the total, whilst in the year ended March 31, 1948, the figure had risen to 60 per cent.

Regular shows and sales are held at York for the disposal of selected stock, and to avoid the inclusion of inferior animals, a panel of breeders is ever watchful in the interests of new buyers.

Ayrshires Much of the West Riding, and the Pennines in particular, has proved eminently suitable for the Ayrshire, which has clearly shown ability to thrive and produce milk economically from extensive areas of second-class grass.

At the moment a good deal of interest is attached to the first-cross Ayrshire-Shorthorn, but it is hoped that the time will soon come when more breeders will be convinced of the value of the grading-up scheme of the Ayrshire Society.

Yorkshire is now able to provide facilities for shows and sales organized by either the North-Eastern or North-Western Regional Branches of the English Ayrshire Cattle Breeders' Association. York and Otley markets are becoming popular centres for the disposal of animals of this hardy breed of cattle. The claims to singleness of purpose, longevity, and ability to breed true to type, are too well known to require emphasis in this article.

Breeds of small dairy cattle such as Jerseys and Guernseys have adapted themselves to Yorkshire conditions and have shown by national milk records to have created a high standard of performance, but the majority of cattle breeders in all three Ridings tend to be conservative in their choice of cattle.

National Milk Records Reference to the progress of milk production would be incomplete without allusion to National Milk Records, under the aegis of the Milk Marketing Board. The county is able to point with some pride to the remarkable achievement of the Yorkshire Branch : whereas the total membership in 1938 was 108, on April 1, 1948, the membership stood at 1,770. Great progress has also been made with butter-fat sampling, nearly 150,000 samples being dealt with last year. Some of the reasons for this increased membership can be attributed to the need to record for the purpose of rationing food according to yield, selecting the best heifer calves for herd replacements, the increased demand from dairy farmers for dairy licences under the Ministry of Agriculture's Bull Licensing Scheme, and to the advice which Livestock Husbandry Officers and District Officers of the N.A.A.S. are continually disseminating in connection with the advisory herd surveys or visits.

Artificial Insemination So far the advantages of artificial insemination have been available only to some breeders in the North Riding, where two sub-centres are now operating from the parent centre at Shincliffe, County Durham. It is too early yet to furnish any informative figures here, but there can be no doubt from the existing res-

ponse that the demand will prove heavy once the projected centres at Beverley and Ilkley, promised for the 1949 programme, start operations. Some 7,000 cows were inseminated from the Shincliffe centre during the last full year, and it is considered probable that a similar number could be expected annually from both the new centres. To get the best results from the use of A.I. entails a policy of upgrading to a definite breed ; indiscriminate cross-breeding must be deprecated.

Healthy Stock Good progress in cattle breeding is synonymous with good health, and it is largely due to the sound common sense of Yorkshire breeders that satisfactory progress in attestation is recorded. The importance attaching to the safer exchange of attested stock is emphasized by the provision of a cattle market solely for this purpose at Otley, and when the improvements now in progress at York Market are completed further facilities of this kind will be available.

Beef Stores The Minister's special appeal last August for more beef stores, together with the assurance of better prices and a calf subsidy, offers a better outlook for breeders, rearers and feeders of this type of cattle. At present there are not many breeders of the recognized colour-marking bulls in Yorkshire, but in recent months there has been an increasing demand for bulls of the Hereford and Aberdeen Angus breeds, as well as the progeny of this mating, from several districts of this county. As an indication of what can be done towards producing more beef for the nation, the large livestock exhibit displayed by the N.A.A.S. stand at the Royal Show should prove of considerable interest to farmers and townsfolk alike.

Sheep Before World War II far more sheep were kept in Yorkshire than at present. Ploughing-out resulted in great reductions in all parts of the county, and large numbers were dispersed from the Wolds to make way for tank training. The demands of war did not complete the trials of sheep farmers in recent years, for few of them are likely to forget the effects of the 1947 blizzards, when the death roll amongst hill sheep amounted to nearly 25 per cent. It has to be borne in mind that the Hill Sheep subsidy aims at maintaining the hardy breeds of mountain sheep and has had a profound effect on the economics of hill sheep farming.

Types locally famous include the Swaledales, the most numerous of hill sheep in the area and well adapted to hard conditions. Rather lower down the hillside, and in circumstances less rigorous as a rule, a considerable proportion of the Swaledale flocks are mated to Wensleydale tups to produce the famous Masham. The Southern Pennines, particularly near the industrial areas, are stocked mainly with Lonks and Gritstones, but in recent years there has been a tendency to infuse the Swaledale blood into these two breeds.

With the types maintained on marginal lands, e.g., Mashams, where flocks are maintained by draft ewes from higher hill farms, there may be further changes by the use of the Down tup to produce fat lambs Some Masham wethers also migrate to grass and arable farms for fattening.

Owing to the setbacks mentioned in the preceding paragraph, Yorkshire flockmasters have a hard struggle ahead to rebuild their breeding stocks to meet the demand for half-breds created by the extension of new leys.

Pigs Pig breeding in Yorkshire has been famous for generations, and many well-known prefixes originated in the county. Despite present feeding difficulties, there are a number of good herds maintaining a

nucleus, at least, from which to expand when times improve. Though Large Whites are without doubt the most popular breed in the county, to which it is said they owe their origin, Berkshires have for many years claimed a fair measure of support. More recently Essex breeders have been steadily securing a number of fresh supporters, and Tamworth and Large Blacks have not been overlooked. Amongst the lesser known breeds is the Yorkshire Blue and White, a product of the North Riding, and appreciated by small pig-keepers for many years.

Regular shows and sales at York and Doncaster have produced a healthy outlet for breeders, and if outstanding prices have not been frequent the regular attendance of buyers from all over the country testifies to the confidence displayed by buyers and sellers alike.

An encouraging sign noticeable of late is the steady demand for Premium Boars in connection with the Ministry of Agriculture's scheme, and the N.A.A.S. exhibit on the Knavesmire shows a typical example. Further particulars of the scheme may be obtained at the stand.

Horses Distressing to all horse-lovers, but none the less a factual reflection of present-day conditions, is the disappearance of the teams of Shires from the "Broad Acres". Far fewer heavy horse stallions now travel the roads, and few men have the time, perhaps even fewer the ability, to break in the colts and fillies. The result is that prices for all but the outstanding youngsters fail to reach a satisfactory level; indeed not an inconsiderable number of fine young horses are being exported to the Continent.

On the other hand, the Cleveland Bay, a truly Yorkshire product and well known at the Royal Mews, is still popular. Indeed the demand for these strong-boned, fast-moving horses can be met only with difficulty.

Those sturdy little horses—the draught horse in miniature—the Dales Ponies, are declining in number, and only those who know their capabilities can fully appreciate their true value.

Conclusion Undoubtedly there has been a long period of change, in cattle and sheep especially, and the tempo has increased during the the last six years.

Frills and fancies have little attraction for the solid character of the Yorkshireman. Whilst conscious that these changes are taking place, he will continue to make his full contribution to the national larder.

WOOL — FROM FARM TO FACTORY

F. Pickles, M.Sc., F.T.I.

University of Leeds

WOOL has long been an important item in the economy of Britain, and was indeed for several centuries the major source of our prosperity.

After the Norman conquest, England became a large exporter of wool, chiefly to Flanders, and in the fourteenth century was exporting forty-four different brands. But with the immigration of Flemish weavers the export of wool declined, and the manufacture and export of cloth increased.

Today there are some forty distinct pedigree breeds of sheep, each with its own society and flock book of registered sheep. The holding of agricultural shows has assisted in maintaining this high standard of quality.

The wools produced in this country may be divided into four main classes: (1) Mountain and Moorland, (2) Lustre, (3) Demi-Lustre, and (4) Downs.

Mountain and Moorland The mountain breeds comprise the Scotch Blackface, Herdwick, Lonk, Swaledale, White Welsh, and others. The wool grown by the Scotch Blackface pastured on the mountains of Scotland is of a rough type, hairy and kempy, with an undergrowth of fine wool, and containing some black and brown fibre. These wools are usually classed as carpet wools, but they are also used for coarse tweeds, and, because of their resilience, as stuffing for mattressess. When Blackface sheep are transferred to the lowlands the wool tends to grow finer.

The Herdwick sheep are a class by themselves; their wool is the roughest grown in the country, and contains much coloured fibre and kemp. By judicious sorting of the coloured wool, interesting stripe and check designs in tweed styles may be produced. These wools are also used in the carpet industry.

White Welsh wool is a short-stapled mountain type. It is characterized by the presence of kemp and a peculiar soft handle. These wools are used in the manufacture of flannels, blankets, and Welsh tweeds.

Lustre The chief lustre breeds are the Lincoln, Leicester, Wensleydale, and Devon. Lincoln wool is long in staple, uniform in fibre diameter, and possessed of good lustre and great strength. Because of these attributes it is used for braids, linings, and seed crushing cloths. The long hogg wool is used in making roller lapping tops to wrap the rollers of wool scouring bowls, where durability and resilience are essential requirements.

Leicester wool is slightly finer than Lincoln, and is used for similar purposes.

Wensleydale or Ripon wool is the most lustrous of British wools and the staples of its fleece hang in characteristic pirls. Cloth made from this wool and given a wet raising process in finishing develops a "ripple" effect which is sometimes fashionable for ladies' coats.

Devon long wools are renowned for their strength and durability, being specially suitable for bunting cloths, belting yarns and press cloths.

The tendency in recent years has been for lustre breeds and wool to decline. This is due to the rise in production of the rayon fibre which has superseded lustre wools in the manufacture of lining cloths.

Demi-Lustre Demi-lustre and half-breds comprise wools from the Romney Marsh sheep, known as Kent tegs and wethers. These wools, when shorn from well-bred sheep, are of good quality; they are free from hair-like fibres and suitable for hosiery manufacture.

Masham wool comes from half-bred sheep obtained by crossing a mountain breed with a lustre breed, say a Blackface ewe with a Wensleydale ram. This wool is suitable for worsted serges.

Downs Down sheep and wool are represented by the Southdown, Suffolk, Shropshire, Dorset, etc. Southdown is the finest grown British wool, and it is claimed that Southdown sheep possess Merino blood. The wool is almost free from black hair, is short in staple length and fairly

fine in fibre. It possesses a loftiness and resilience which make it ideal for home knitting and general hosiery purposes.

The Cheviot is a hill sheep, largely kept in Scotland and the north of England. The best qualities of Cheviot wool are akin to Down wool in character. They are lofty, springy, full in handle and eminently suitable for hosiery and tweed manufacture.

Other wools of the Down type have similar characteristics, according to their quality.

A feature of some Down wools is the presence of coloured fibre in the fleece. The Dorset Horn is normally free, but the Shropshire and Suffolk are offenders in this respect. Knitted and woven fabrics which are to remain white or to be dyed light colours, call for wools free from this defect.

In addition to hosiery, Down wools are largely used for papermakers' felts, to cover the rollers in the pulp grinding machines in paper-mills. Loftiness and resilience are important in wools used for this purpose.

Clean Fleeces It is sometimes said that the British farmer pays more attention to the carcass than to the wool. This, of course, is a matter of economics, but wool is now more valuable than it has been for many years, and the wool grower can assist the wool user and processor by careful handling before marketing it.

The marking of sheep to distinguish ownership is important, but tar and the paint materials often used cannot be removed in the wool scouring process. The use of such indelible materials should be abandoned in favour of marking fluids which dissolve in the scouring process.

At shearing time and during storage, care should be taken to prevent straw and other vegetable matter getting mixed with the wool. Vegetable matter does not take wool dyes and has to be picked out of the woven fabric by women burlers, and that means additional expense. Neither should binder twine or string be used to tie up the fleeces

Sorting the Wool The wool merchant having obtained the wool proceeds to process it to the best advantage. A fleece is not all of one quality, and it is necessary, therefore, to sort the wool into its several qualities—perhaps six or more, according to the type of fleece. The fleece is placed on the wool-sorters' table facing a north light, and skeps are placed round about to receive the different sorts as they are detached from the fleece.

The sorter's skill depends upon sight and touch. He acquires an excellent knowledge of wool during his apprenticeship, which enables him to sort it quickly and accurately.

In addition to categorizing several qualities of the fleece, the sorter must remove tar-bits, stained britch staples, kempy parts, coloured staples, and vegetable matter.

Having filled his skeps, the sorter passes them on to the "taker-off," who checks the qualities. The wool is then dropped into large bins, along with wool of the same qualities from other sorters. These are termed "matchings," representing wool from many fleeces and many sorters, and all of the same quality.

Quality numbers are assigned to wools—as, for instance, 50s. This formerly indicated that 1 lb. of 50s would spin to 50s worsted yarn or 50 hanks of 560 yards each. This is not always the case at the present time.

Blends are made from the sorted wools according to requirements, and the first of the mechanical operations follows. All wools contain natural grease and acquired impurities, which must be removed. This is done by scouring. The procedure is to pass the wool through a series of large

bowls containing soap and alkali solutions to dissolve the grease, leaving the wool clean and undamaged.

Woollens and Worsteds Carding follows, and here the wire-covered rollers tease out the wool fibres into a thin layer, which later leaves the machine in sliver or rope form, coiled into large balls.

If the material is intended for woollen yarn and cloth, the carded sliver is condensed to a finer sliver and spun to the thickness or count of yarn desired.

For worsted yarn and cloth, the carded slivers have to be combed. In the combing machine the short fibres and any remaining vegetable matter are separated from the longer fibres. The short fibres are termed "noils" and are used in the woollen industry. The longer fibres are laid in a straight line and parallel to each other and are known as "tops". These top slivers are subsequently passed through a series of drawing machines which gradually reduce the thickness of the sliver. Finally, the worsted yarn is spun on the spinning frame to the required count and twist.

As already indicated wool may be processed to produce either woollen or worsted material. To the man in the street wool goods are usually spoken of as woollens. The difference between woollen and worsted can be defined as follows: *Woollen cloth* is made from yarns spun from carded slivers in which anything but a parallel position of the fibres is found. Woollen cloth is generally milled and shrunk in finishing, thus hiding the surface structure. *Worsted cloth* is made from yarns spun from combed slivers in which the fibres lie parallel to each other. After spinning, two threads may be twisted together to make twofold yarn, which gives a firm and solid cloth. Worsted cloth is usually clear finished to show the character of the yarns and the weave structure.

Woven and Knitted Fabrics After spinning comes weaving. A woven fabric is made by crossing two series of yarns at right angles to each other and interlacing them to any desired pattern or design. One series is called warp and the other weft. A warp is first made containing the requisite number of threads, placed on the beam to the required width and fixed in the loom. The warp threads run lengthwise and parallel to the selvedge. The weft threads cross at right angles to the warp.

In weaving, a set of heald shafts raise and depress the warp threads according to the design to make an aperture for the weft to pass through. The weft is carried across in a shuttle propelled by picking arms operating at each side of the loom. A sley beats up each pick inserted into close contact with its predecessor in the cloth already woven. As weaving proceeds, the warp is gradually let off from the beam and the woven cloth wound round the cloth beam. After weaving, the cloth is inspected for imperfections and mended where necessary.

In addition to woven fabrics, another class of material is made by knitting. A knitted fabric is composed of a single thread which interlaces with itself, forming a series of loops each dependent on the succeeding one for security. A knitted fabric is distinct from a woven fabric in that it is built up upon itself, whereas a woven fabric consists of two series of threads crossing each other at right angles.

Finishing and Dyeing All cloths need to be finished before they can be made up into clothing. Cloths made from dyed yarns need finishing only, but cloth woven with white yarn requires to be dyed.

Oil is added in the early processing of wool, and the cloth has therefore to be scoured to remove it. Then follows dyeing, blowing or crabbing, brushing, raising, cutting, and pressing to give a permanent finish.

Worsted cloths change comparatively little in appearance during dyeing and finishing, but woollen cloth is milled and shrunk, making it more compact and giving it a felt-like appearance.

Formerly considerable loss was caused by wool goods—particularly knitted underwear—shrinking during laundering but, as a result of recent research, this fault has been rectified by chemical treatment. Moth damage—another serious trouble—has been overcome by efficient proofing.

COMMERCIAL HORTICULTURE IN YORKSHIRE

P. H. Brown, N.D.H.

National Agricultural Advisory Service, Yorks and Lancs Province

THE great variations in soil and climate which characterize the vast area of Yorkshire are reflected in its horticultural production.

Market gardening of a mixed character developed many years ago near the large towns and industrial centres, such as Leeds, Wakefield, Bradford, and Doncaster in the West Riding, and Middlesbrough and Hull in the North and East Ridings. These are still prominent producing centres, though the type of produce is now better attuned to soil and climate. One example of this is the highly specialized production of forced rhubarb and spring broccoli which now occupy a considerable proportion of the old market-garden land of the industrial parts of the West Riding. Another is the large-scale production of crops under Dutch lights near Hull—an industry developed since 1935 and which is today the largest concentrated area of the kind in the country.

Soils and Climate in relation to Horticultural Production On the clays of the coal measure series around Bradford, Leeds and Wakefield, the character of the soil of the market-garden land has been substantially changed by repeated applications of town ashes.

Next we have a narrow belt of magnesian limestone running the whole length of the county from north to south, and beyond this the Plain of York consisting of glacial and part-glacial drift, sandstone and alluvium, on which there is a substantial amount of horticultural production. To the east lies the chalk of the Wolds, with a small basin of alluvium around Hull on the south side and a larger one on the northern side constituting the Vale of Pickering. Finally, on the extreme eastern side are the clays and siltland which stretch away to the coast.

The average annual rainfall in the western half of the county ranges between 30 and 40 inches, and a large proportion of the horticultural production of the West Riding falls within this belt, which is also the chief industrial (and smoky) area. Eastwards, on the Plain of York, the Wolds and the Holderness district the average annual rainfall is not more than 20-25 inches.

In the Pennine area the average annual sunshine is below 1,200 hours. A narrow strip of the East Riding coastline including the Hull area enjoys 1,400-1,600 hours. The rest of the county—that is, between these two belts—falls between the two sets of figures given.

On the western side horticultural production consists mainly of the hardier kind of vegetables—cabbage, broccoli, rhubarb, and peas in particular. On the eastern side intensive market gardening and particularly Dutch-light production are the chief features. On the lighter land very large acreages of carrots, potatoes and peas are grown.

Roughly, horticultural production may be summarized :

66 per cent on the light soils (alluvium and sandstones), with low rainfall and average sunshine and temperature ;

25 per cent on heavy soils (millstone grit and coal measure clays), with high rainfall, industrial smoke, and low sunshine and temperature ;

9 per cent on other soils with variable climate.

Production of Horticultural Crops In 1947 the total of all horticultural production in Yorkshire was approximately 50,000 acres, made up as follows :

	acres
Vegetables	47,000
All crops under glass	240
Outdoor flowers	233
All fruit	2,150
Nursery stock	380

VEGETABLES An analysis of the vegetables grown shows that by far the largest single item is peas (24,000 acres), just one-half of which are peas for drying. Practically the whole of the latter are grown on contract in the Holderness district. Peas for pulling green are grown principally in the Selby and Doncaster districts on the light soils, and the area under this crop during the past years has been maintained steadily at approximately 7,000 acres.

Next in importance is the carrot crop, covering nearly 5,000 acres. The majority are maincrops for clamping (" pieing " in Yorkshire) and are grown on the light " sand land " areas centred on Market Weighton in the East Riding, Selby in the West Riding, and Thirsk in the North Riding.

Brassica crops are also important, their production being widely distributed throughout the county. The total acreage grown in 1947 was 7,500, made up of 3,250 acres of cabbage, 2,850 acres of cauliflowers and broccoli, and 1,400 acres of Brussels sprouts. Approximately 70 per cent of the cabbage and broccoli is produced in the West Riding, whereas a substantial proportion of the early summer cauliflowers is grown in the East Riding, on the more intensive market gardens.

The rhubarb industry is, of course, of considerable importance, and some 5,000 acres are devoted to this crop. More is said about this later.

CROPS UNDER GLASS Under this heading is included both crops in permanent glasshouses and under Dutch lights. Statistics show that there are approximately 95 acres of permanent glasshouses and 145 acres of Dutch lights, though the figure for the latter has increased very considerably in the last twelve months and is now approaching 200 acres.

The type and size of the permanent glasshouse vary ; there is a number of small low houses in addition to the larger vinery and aeroplane type. The main crops in permanent houses are tomatoes, followed by late chrysanthemums, though not a few growers produce bedding plants and force bulbs as well. The low-type houses are not ideal for tomatoes and yields are not very

high—about 30 tons per acre on the average. In the larger houses, however, yields of 45-50 tons per acre are obtained regularly.

It is only in recent years that winter lettuce has been grown to any extent in heated houses.

Grape vines are an old-established crop in the concentrated glasshouse area around Howden in the East Riding. Before the war grapes were exported from here to the Continent at Christmas time.

Very few glasshouse flower crops such as carnations are grown in Yorkshire, and most of the outdoor flower production is in the hands of growers selling direct to the shops. The main lines are pyrethrums, scabious, dahlias and chrysanthemums.

As will have been observed, Dutch lights (both on frames and " structures ") have outgrown the standard glasshouse, and their use of these has now spread over a large part of the eastern half of the county.

FRUIT Yorkshire cannot boast of very much fruit, though before the first world war a fair acreage of strawberries was grown in the Cottingham and Driffield areas of the East Riding. Some interest is again being shown in soft fruits, principally strawberries and black currants. Furthermore, some high land near Thirsk has recently been put down to strawberry runner production.

That fruit can be grown successfully on suitable sites in Yorkshire there is no doubt, and the experimental plantations at the Institute of Agriculture, Askham Bryan, have done much to prove this. Looking around the county, one sees quite a number of areas suitable for fruit growing, particularly around Pickering and Ripon.

NURSERY STOCK Yorkshire certainly cannot claim to approach a county such as Surrey in acreage of nursery stock, but it does provide a fair amount of planting material, and some of the nurseries in the county can claim a world-wide reputation.

Specialities: RHUBARB As already indicated Yorkshire has a few well-known specialities. Who has not heard of Yorkshire's famous rhubarb, and who has not wondered why the cultivation of this crop should be so successful in this part of the country? The crop in Yorkshire is grown almost exclusively for forcing. Rhubarb for outdoor pulling is not a difficult crop to grow but forcing is another matter. To obtain a really suitable root for forcing two things are necessary—maximum root and crown development, and absolute dormancy prior to forcing.

The industrial area of the West Riding in which this rhubarb is grown has a high rainfall, which gives maximum growth. Secondly, the smoky and polluted atmosphere brings about the early and complete dormancy required and thus allows of early forcing. The other factor is, of course, the accumulated knowledge and experience in the forcing practice which has been passed down from father to son, for this work is, without doubt, a craft and many " tricks of the trade " are jealously guarded.

That the industry is considerable is borne out by the fact that nearly 5,000 acres of roots are grown for taking into the forcing sheds. These roots are usually lifted for forcing when three years old, though some growers force at two years old. The roots are packed tightly together on the floor of the shed, the number working out to approximately nine to the square yard. The yield is in the neighbourhood of 36 lb. per sq. yard of roots in the shed.

The sheds are heated either by the old method of flues or with hot-water pipes. The crop needs a fair quantity of water, which, in most cases, is applied by hose-pipe, though many growers have recently equipped their sheds with overhead irrigation.

The sheds are kept absolutely dark, otherwise the colour and quality of the sticks would be seriously affected. Work amongst the crop is carried out either by candle-light or a low-powered electric light.

Until war-time conditions militated against it, the sticks were bunched in half-pound bundles. There were always mixed views on this point, and today many growers hope that they will never return to the old practice. The quantity of forced rhubarb dispatched during the season each day to markets all over the country is considerable. Before the war a special train, known locally as the "Rhubarb Special," left Leeds for London daily.

BROCCOLI The companion crop to rhubarb in the West Riding is broccoli, a crop that fits very well into the rotation with rhubarb An interesting point is that it is difficult to find any of the standard varieties of broccoli growing in the West Riding. The growers have built up types and strains of their own and produce and harvest their own seed. These local types have two important characteristics—lateness and well-projected curds. The growers have always aimed to market their broccoli *after* the crop in the south has finished, and they have selected the plants for seed saving to this end—that is, to give crops for cutting from late April to early June. Naturally they guard their own particular stocks of seed carefully, and little is available through the normal channels.

The industry has not been without its troubles, and for some years Stem Rot (*Phoma lingam*) took heavy toll of the crops. This disease was studied carefully by Dr. Millard of Leeds University who, finding that it was seed-borne, introduced the warm-water treatment of seed and for a number of years treated growers' seed for them. This service is now provided by the West Riding Agricultural Executive Committee, and many growers are having their stocks of seed treated. About 1,500 acres of the late broccoli are grown in the area every year.

PRODUCTION WITH DUTCH LIGHTS This speciality embraces 200 acres and is of recent origin. It was introduced into the Hull area about 1935 by a few Dutch " settlers". The local English growers were slow at first to adopt the new idea but gradually interest grew and before long the practice was becoming established. By 1939 it had spread into other districts of the East Riding and to parts of the North Riding. Lack of materials prevented further extension during the war but there have been some additions in the past twelve months or so.

Methods and cropping are similar to those practised in Holland, where the system is based on " single " cropping rather than " multiple " cropping as adopted in the southern counties—the latter being more akin to the once popular type of " French gardening".

In the East Riding the Dutch lights are used in both frames and " structures "—the latter being a framework of timber or steel into which lights are fixed to form a " glasshouse". No heating is used either in frames or structure, the object being to bring crops forward, not force them, and so fill the gap between produce from heated glasshouses and that from outdoors.

There are three systems for using the lights :

(1) on frames for a spring crop of lettuce and followed in summer by cucumbers or melons ;

(2) on " structures " for a spring crop of lettuce followed by tomatoes ;

(3) on frames in spring (as above) and then transferred on to " structures " for a summer crop of tomatoes.

It will thus be seen that the principal crops are lettuce, tomatoes, cucumbers, and melons, and these represent 95 per cent of the total production. A number of other salad crops are grown in addition, as well as flowers such as iris, gladioli and zinnia. The only "mixed" cropping practised is the interplanting of the lettuce in frames with extra early cauliflower.

Taking the four principal crops mentioned above, the estimated output of produce from the 200 acres of lights is given in the following table. The figures are based on average yields and on the assumption that the number of lights on frames and "structures" is practically equal.

	No. of acres grown	No. of lights per acre	Yield per light	Yield per acre
Spring lettuce—in frames ...	100	2,720	1 crate (18-24)	2,720 crates
Spring lettuce—in "structures"	100	3,400	1 crate (18-24)	3,400 crates
Tomatoes—in "structures" ...	100	3,400	18 lb.	30 tons
Cucumber—in frames	75	2,720	24 lb.	30 tons
Melons—in frames	25	2,720	3 fruits	8,000 fruits

The total output for the 200 acres is therefore approximately 612,000 crates of spring lettuce, 3,000 tons of tomatoes, 2,250 tons of cucumbers and 200,000 of melons.

Production with these Dutch lights is nearly always found in combination with an appropriate area of outdoor crops, the objects being to provide a continuous supply of produce for the market over the year and to spread the labour evenly.

The growers aim at producing the lowest possible cost and, to this end, many of the cultivations are done by machinery, and watering by overhead irrigation lines installed in the frames and "structures".

Some growers have designed steel "structures" for their use, and it is now a regular thing to find workshops, with a complete set of tools and appliances, including oxy-acetylene welding, on many of these holdings.

Conclusion The production of vegetables, glasshouse crops and fruit in the north is not nearly adequate for its population and therefore, whilst the output from Yorkshire is considerable and of good repute, there is ample scope for further development.

There are still many acres of highly fertile alluvial soil ideally suited to vegetables and cropping under Dutch lights. Also it is thought that more fruit growing would prove worth while.

YORKSHIRE FARMING IN THE PAST

G. E. Fussell, F.R.Hist.S.
Ministry of Agriculture and Fisheries

FOUR hundred years ago Yorkshire must have been sparsely populated and thinly farmed. He was a clever man who could find his way without a guide to the "Spaws of Harrogate"; and from Newark in Nottinghamshire to the border was then a tractless waste, known only to the "locals" and the itinerant drovers, robbers and reivers.

Sheep ranching was doubtless the order of the day on the moors and wolds, and there may have been cattle grazing the lower lands. Grass and corn were plentiful in Holderness and the vales, where large lumbering Holderness cattle were bred, but the carrs were an extensive swamp producing little but the ague; willow trees marked the road from Hull to Beverley, and inland no dry stone walls had yet been built.

Henry Best, who farmed in the county in the seventeenth century, has left a clear account of his shepherding (1641), and it is likely that his practice was fairly general. He kept one ram, not younger than two years, for every thirty or forty ewes, which he arranged to be tupped round about October 18 (some farmers did this at Michaelmas). Just before tupping the ewes were put on fresh stubbles, preferably oats, or, failing that, barley, as the fresher and richer food made them "ride" better. At this time ewes were kept for milking, and where they were wanted for this purpose the lambs were weaned at Helenmass; otherwise the lambs were allowed to suck as long as they would. Best kept his sheep in a low "springy" close until March 10 and then moved them to a new close of grass. About the middle of April they were given wider range and then folded from about May Day until the end of September—indeed as long as the corn was in the ground. They were washed and shorn in the early part of June, and the ram lambs were castrated at the same time.

Enclosure Both Holderness and the vales were in open field villages, where the farms consisted of the usual strips of arable scattered over two or more large fields. The North and West Ridings were enclosed much earlier than the East Riding because the predominance of pasture farming always led to early enclosure. Leland, in the early sixteenth century, found chiefly moor and forest, though more enclosed arable than "Chaumpaine" or open field, but by the end of the seventeenth century Celia Fiennes found that much land had been enclosed. This enclosure process was pushed steadily forward, mainly by tilling and enclosing common wastes and pastures and clearing and cultivating the forests in the North and West Ridings. The Vale of Pickering was enclosed in the first half of the eighteenth century; the south of Yorkshire and the Wolds by Act of Parliament in the second half of the eighteenth century and beginning of the nineteenth. Walter Blith remarked in 1650 that the Yorkshire "woodlands—nominal forests and chace—were amongst those wont before enclosure to be relieved by the champain and was become gallant corn country".

Arable cultivation on the open fields was much the same in Yorkshire as elsewhere. It was the proverbial wisdom of the Jacobean age that wheat should be grown in the dirt and rye in the dust. For these crops three ploughings were given—in autumn, spring, and summer—the winter corn being sown immediately after harvest and sometimes, in a late season, before. At this time also the spring corn land was being prepared, because spring crops were sown earlier than they are today; January for oats, February for fitches. Three ploughings prepared the seedbed, as for winter corn.

In Charles II's reign Yorkshire farmers believed that if they brought their seed from a barren district it would flourish on better soil East Riding men obtained seed "from swarth new tilled into arable" and had great success in bringing "pined corn into strong land". Others reported: "wee take our seede Wheate which grows Northward of us, and upon a hungrier soyle, and Rye from a weepinge Sand to sowe upon a drye, And Barley from a warpe to sowe upon sand or clay." In the Ripon district the wisest bought their seed from "Common till'd ffields" and Wharfedale farmers believed that they kept away smut by "buying the purest wheat growing in the more

champion country about 12 miles off, near Wetherby, as those who theyr have the best seed do yearly buy theyrs att like distance off, about York". Wheat seed was steeped in slaked lime, in brine, or urine before sowing. A sort of ley husbandry had recently been adopted by some farmers around Ripon. Old pasture and moor were pared and burnt, and three or four crops then taken : first barley, next maslin, then barley, and last peas, beans or oats. The land was then dressed with a small quantity of lime and dung, or marl and dung, and left to fall down ; and, optimistically remarks the report, " good pasture ground follows".

Although the woollen industry was still in the domestic stage, Defoe could say, in 1724, of the district around Halifax " a circle of twelve miles Diameter, like a planted garden, or a colony : where every family lives, as it were, within itself and by itself," and each kept a cow or two. It was in such surroundings that Goldsmith's Vicar of Wakefield spent his days :

> The place of our retreat was in a little neighbourhood consisting of farmers, who tilled their own grounds and were equal strangers to opulence and poverty. As they had almost all the conveniences of life within themselves, they seldom visited towns or cities in search of superfluity.

When Arthur Young travelled through the county in 1769 from Barnsley to Wakefield, Leeds, Tadcaster and Winmoor, he remarked on the amount of oatbread being eaten, showing how widely oats were grown at that time, but between Doncaster and Rotherham the rotation was : fallow—beans—barley —wheat. Some experiments with cabbage for stock feed had been started near Rotherham, where the Marquis of Rockingham was setting a splendid example of improved farming, and quantities of potatoes were also being grown in the open fields around York and at Cottingham. The Wolds were then being enclosed rapidly, sainfoin introduced, and the four-course arable sheep system being developed, but a great deal of this work came later— between 1770 and 1850. Sir Digby Legard was enclosing his 6,000-acre Wold estate and described the process in a letter to Arthur Young. The whole countryside was transformed in half a century, becoming as productive as the Lincoln Wold across the Humber.

By 1794 the Norfolk four-course sytem was the most common in the West Riding, but the turnip culture was poor. Some sainfoin was grown, winter tares in many places and flax along the Ouse. Dung and lime were the usual manures, with some bone and horn dust from the Sheffield cutlery makers, and rape dust.

After the Napoleonic War Some 40,000 acres of Holderness had been drained by 1797 and 30,000 acres more were in hand. The country was at war with France and, agriculture, stimulated by high prices and large profits, progressed by leaps and bounds. But after the war came the slump. Various Select Committees sat between 1821 and 1836 to consider its effect upon farming and to suggest remedial measures. They heard a great deal of evidence but failed signally to find a remedy.

William Stickney of Ridgmount Farm, Holderness, a clay farm of 540 acres, told the Select Committee of 1821 that he used a two-horse plough and a special plough for clearing furrow drains. Cup-drills made by Perkins were used for sowing turnip seed and bone dust together. Horse skims and Dutch hoes were used, and a dibbler for cereal seed. On this farm a bare fallow every five or six years was necessary, and the rotation was : fallow, fully manured ; wheat, red clover mown and slightly limed ; wheat ; beans. Variations to include oats and rape grown for seed were made as necessary. Wheat was grown five times in eighteen years. Some swedes and cabbages or rape on the fallow provided sheep feed. A few potatoes

were also grown. The farm included 240 acres of grass, most of which had been laid down during Stickney's tenancy. The flock had been improved by using Leicester rams; the old breed of cattle, crossed with improved Teeswaters, had gained early maturity and aptitude to fatten. The common Yorkshire breed of pigs, crossed with Neapolitan, was kept on straw in fold-yards and the progeny sold at 12 months old for fattening. Only of late years had field drainage been attended to.

The Watson family had occupied a 1,000-acre farm at Wauldby on the southern extremity of the Wolds for fifty years in 1840. The furze and thorn had been cleared and the land broken up. Some leys had been down for thirty-five years. They were weeded carefully and turnips spread on them for sheep, thus restoring some of the fertility. A seeds mixture of 17 lb. white clover, 2 lb. ribgrass, and 3 lb. red clover, if clover was not to be sown in the next course, was used. The turnip ground was prepared very carefully, ploughed and harrowed and every weed picked out. The crop was heavily dunged and 12-16 lb. bones drilled with the seed by a combine drill. In addition to this then very modern machine, a two-horse plough, Finlayson's harrow, and a threshing machine were used. The rotation was an elaboration of the four course—turnips fed off; barley undersown; seeds principally stocked with sheep, but also grazed by young Shorthorns; seeds part-fallowed; wheat and oats. Beans, peas and tares were put in occasionally. Rape had been grown in the past few years on the fallow for sheep. Only a few potatoes for domestic use were grown. Stable manure was collected from Hull, as it had long been, and some chalking was done. Sheep were the main livestock, a Leicester cross on the old breed, and sold at Weighton fair at Michaelmas. A few cows were kept for domestic milk, and a few beasts bought in for winter yard feeding, just as were pigs for feeding on the stubbles. Cleveland bays were used for draught but none was bred, although large numbers of these horses were bred in and around the district that gave them its name.

When James Caird visited the county in 1850 the small farms near the big towns were still occupied by clothiers. There were some improvers. Mr. Stansfield of Esholt, for example, followed the strict four course, manured heavily and had some irrigated meadows, as well as a small acreage of Italian ryegrass that was cut green for soiling, and some kohlrabi grown for feed. Caird approved of the seeds mixture which Stansfield used, carrying, as it did, 8-10 sheep per acre in summer. His cereal yields were high for the time, 32-56 bushels of wheat, according to the season, and 64 bushels of barley.

From Otley to Harewood were well-managed farms of about 200 acres. Chevet Grange between Wakefield and Barnsley comprised 280 acres of good, sound land one-third grass and two-thirds four-course arable, keeping 3-5 sheep per acre, some 20-30 beasts being fattened in winter on straw and 4 lb. oil cake per head. Eight horses were kept and worked the threshing machine. Pigs were fattened on Egyptian beans. The occupier had several other farms besides this. The cattle over the whole Riding were improved Shorthorn and the sheep Leicester, though the pure Leicester was giving place to a cross between a Shropshire ram and Leicester ewe. Fine hunters were bred around Doncaster, Wetherby and Ripon.

Some special crops were grown at this date on the alluvial soils near the rivers. Flax, woad, teazles and carrots were " largely " grown, and mustard was a good paying crop and a preparation for wheat. Near Goole and Selby potatoes were grown on the warp land for the towns and for London. The large quantity of town manure available made possible the growing of potatoes, and wheat or oats alternately, for an indefinite length of time. Around Bawtry, Tadcaster, Whisley Green, Hamerton and Boroughbridge

a six-course rotation was practised. It included tares for soiling, turnips, cabbage, and potatoes. Liquorice was a speciality near Pontefract.

Within the compass of a short article it is not possible to do full justice to the farming history of Yorkshire, but enough has been said, I think, to indicate how deep the farming tradition lies. Other times, other manners; but the essence of farming practice is ageless.

More detailed information on the history of Yorkshire farming will be found in the author's "Three Centuries of Farming Systems in the North and East Ridings of Yorkshire", obtainable from the Castle Museum, York, price 1*s*. net.

YORKSHIRE YOUNG FARMERS

JUST as a style of farming is a reflection of its particular environment, so the character of Young Farmers' Clubs varies with the character of the local farming. The clubs in the dales are in many ways unlike those in the populous parts of the West Riding; and the large arable farms and scattered towns of the East Riding produce clubs and problems that are distinct from those in other parts. The strong family resemblance which all clubs bear to one another is overlaid by individual differences that have their origins in the farming and geographical characteristics of the various regions.

The latest figures are:

	E. Riding	*N. Riding*	*W. Riding*
Total number of clubs ...	16	40	69
No. of school clubs included in above	3	7	18
Membership (approx.) ...	600	1600	3500

The Young Farmers' Clubs of the three Ridings are affiliated to the National Federation of Young Farmers' Clubs. Until 1943 they were united in the Yorkshire Federation of Young Farmers' Clubs, but in that year separate federations were formed. Each Riding now has its own federation and its own organizer (two organizers in the West Riding) and each federation is grant-aided by its County Council.

THE FIGHT AGAINST COLORADO BEETLE GOES ON

If you are growing potatoes, especially in coastal districts, examine your crops frequently. If you come across any yellowish-beetle about ½ inch long, with black stripes running up and down its back, or any red or reddish-yellow grub, put it with a piece of potato leaf in a tin box, *without holes*, and send it at once to the Ministry of Agriculture Plant Pathology Laboratory, Milton Road, Harpenden, Herts., accompanied by a note stating the exact place where found and your name and address. Don't do anything more until instructions are received from the Ministry. Heavy infestations of beetles are reported from the Continent, and a considerable number of beetles have already been found in Britain.

YOUR COLLABORATION IS ESSENTIAL

BOOK REVIEWS

Harvest Home. Prepared for the Ministry of Agriculture by the Central Office of Information. H.M. Stationery Office. 2s.

Never in the recorded history of this country has river flooding been so widespread and of such duration as that which occurred in the spring of 1947. In all, some 690,000 acres were inundated, of which 325,000 acres were arable land, a lot of it the best farming land in the country—and this at a time when the need for home-grown food was unparalleled. Up in the hills some two million sheep and lambs had perished in the snow; down in the plains 30,000 cattle were lost. The total cost of the flood damage has been estimated at £12 million.

The Welland at Spalding rose 6 inches above its previous record. The Great Ouse was carrying more than 10,000 cu. feet per second when the recording apparatus broke down. The Lea rose higher than has been known for the past hundred years. At Worcester the Severn flood was greater than at any time since 1770, and to find a flood of equivalent magnitude for the Ouse at York, one must go back to 1831.

Everywhere the phenomenal falls of snow, following the heavy and persistent rain during January and February, were locked fast in the grip of frost, until suddenly on March 9 the thaw came, accompanied by more, heavy rain. The snow melted, ran across the still frozen ground into the streams and rivers, overflowed or broke through the frost-weakened banks to surge in ever-growing turbulence across the countryside.

Harvest Home is the story of that disaster; of the titanic struggle to hold back the swollen waters by the staff of the Catchment Boards, the land drainage engineers, the farmers and their workers, men and women of all ages, the Navy, the Army, the Air Force, and the men of the National Fire Service, backed by the full resources of the Government; of the selfless service of the women of the W.V.S. who quietly and efficiently succoured the homeless, fed, clothed and cared for them and later, with pails, soap and scrubbing brushes, performed miracles in the muddied houses. This, too, is the story of how ultimately the battle against the floods was won and how the farmers and farm workers returned to the sodden soil of their fields to win yet another fine harvest in the face of dereliction.

S.R.O'H.

Woollen and Worsted Raw Materials. (Second Edition). J. R. Hind. Ernest Benn. 12s. 6d.

The avowed object of this book is to give students and apprentices an introduction to the raw materials used in the wool trade. Its twenty chapters cover: wool production; manipulation of wools for sale; skin wools; wool sales; features and properties of textile fibres; British, European, Australasian, African, American and Asiatic wools; textile hairs; wool sorting; tops and qualities; textile wastes; other textile materials; wool scouring; cleansing wool by volatile agents; wool drying; burring and carbonizing.

This second edition is much the same as the first which appeared in 1934. An exception is Chapter V, which has been rewritten to introduce knowledge gained by recent research into the physical and chemical structure of wool fibre. This further knowledge should be valuable to those engaged in processing the fibre to the finished fabric. The statistics relating to wool production have not been brought up-to-date, and being eighteen years old are of only minor interest.

The methods of marketing British- and Dominion-grown wool are reasonably described, as practised in normal times. Advantage might have been taken to include some account of the methods of purchase and distribution by the Government Wool Control during the war years.

In the chapters dealing with sheep and wool, the importance of British breeds and their influence on flocks overseas is emphasized, and there is an interesting account of the wonderful development of sheep farming in Australasia. The founding of the Corriedale and Polwarth breeds by crossing the Merino with British long-woolled sheep has had a great influence on present-day world production.

The textile industry is now using many types of fibre in addition to wool, and many of them are referred to in Chapter XVI. More attention might, however, have been given to rayon, the production of which has increased considerably during recent years; for certain textiles it has displaced wool, and in others a combination of rayon and wool is being used. The chapters dealing with wool processing describe established practice.

Although intended primarily as a manual for the beginner, this book will be of general interest.

F.P.

BOOK REVIEWS

Bird Haunts in Northern Britain. G. K. YEATES. Faber. 25s.

Any knowledgeable bird lover, told of a new book by Captain Yeates, will naturally expect something good, both as regards writing and photography. Indeed the author is one of the very best of our bird photographers, and has developed a style of writing of equal excellence. This book is in the true line of succession and is, perhaps, the best that the author has yet given us. His accounts of bird watching and photographing in the North are given with an accuracy of detail that marks the expert observer, and, incidentally, they make very pleasant reading.

The author's chapter of Fetlar evoked longing memories indeed. Of it he says: "As a bird sanctuary it is in my opinion *the* island of Great Britain". It always was; it is good to know that it still is.

As to the photographs; were it possible to select pictures of outstanding merit, from such a gallery, one might be tempted to choose those of the dotterel and the greenshank. Outside the ranks of the elite there are few bird-lovers who have ever seen either species at nest, let alone photographed them. Captain Yeates has the rare and enviable knack of catching the essential character of his feathered sitters and, particularly in these two instances, his pictures are portraits in the truest sense. If the coloured photographs in the book are rather less successful that is no fault of the photographer; rather one would suggest that there is still some way to go before photography in colour can be considered to have approached perfection.

The presentation of the book is excellent, and at 25s. it is good value to any bird lover, expert or amateur.

F.H.L.

Introduction to Plant Ecology A. G. TANSLEY. Allen and Unwin. 8*s*. 6*d*.

Ecology is the study of plants and animals as they exist in their natural homes and is of importance to the agricultural student, since, as Professor Tansley says, much of scientific agriculture is applied ecology. This introduction to plant ecology is meant as a guide for beginners in the study of plant communities and is a revised version of *Practical Plant Ecology*, which was published in 1923 and for which there was a demand large enough to require two further impressions (in 1926 and 1932). The present book is divided into five parts: introduction; the structure, distribution and development of vegetation; methods of studying vegetation; the habitat and ecological work in schools. It is the third and fourth parts which are probably of most importance to the student of agricultural botany, and it is to be hoped that they may encourage some to study the autecology, i.e., all aspects of the life, of individual species of weeds. Although a start has been made with the autecology of British plants with the publication in parts of the *Biological Flora*, this aspect of ecology has not received the attention it deserves. The book ends with a useful classified list of 173 books and papers on British plant ecology.

H.W.H.

3424 Wt. 15 7/48 CN&Co 466

The 'Somerspin' P.T.O. Drive Potato Spinner

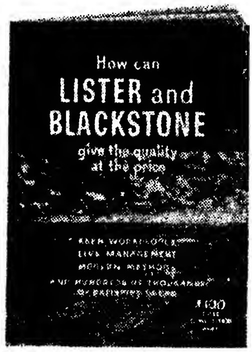
It's a good job—
It's a 'SOMERSET' machine

—and in line with all other products of the famous 'Somerset' range, which comprises Power Drive Tractor Mowers — Hayrakes — Side Delivery Rake and Swath Turner—Haysweeps —Hayloaders—Hay and Straw Balers —Disc Harrows — Combined Grain and Fertilizer Drills—Grain Drills— Fertilizer Distributors — Ploughs — Sawbenches.

Dening of Chard

Phone: Sales Dept. Chard 2284/5 SOMERSET *Telegrams: Dening, Chard*

DAIRY TINWARE • MILK COOLERS • GRASS COMBS • HARROWS • HORSE CLIPPERS • CATTLE CLIPPERS • SHEEP SHEARS • ENGINES • PUMPS • ELECTRIC GENERATING PLANTS • HAY ELEVATORS • TRACTOR RAKES • SIDE DELIVERY RAKES • POTATO DIGGERS



CONTAINS LATEST PRICES
SENT FREE ON REQUEST

R. A. LISTER & Co., Ltd.,
DURSLEY, GLOUCESTERSHIRE
Branches :
LONDON STAMFORD GLASGOW
BELFAST & DUBLIN

BY APPOINTMENT

Webbs'

THE PRODUCERS OF PEDIGREE SEEDS AND MANUFACTURERS OF FERTILIZERS

For over eignty years a succession of highly qualified technicians working at Webb's Plant Breeding Stations and Trial Grounds have evolved great numbers of new varieties and regenerated stocks. The strains produced are as good as applied science and sound practice can make them, and are used by very many eminent agriculturists and merchants as nucleus stocks for the production of their commercial seed.

WHEAT, OATS, BARLEY, GRASSES, CLOVERS, ETC.

EDWARD WEBB & SONS (Stourbridge) LTD.,
WORDSLEY, STOURBRIDGE, WORCS.
Telephone Brierley Hill 7575 (4 lines)

Please mention the JOURNAL *when corresponding with Advertisers*

UNBROKEN GROUND

means Extra Grip and *PULL*

Only possible with the O-P-E-N C-E-N-T-R-E tread

FOLLOW A TRACTOR equipped with Goodyear Sure-Grip Tyres and see what sharp, deep, *unbroken* impressions they leave in the ground behind them.

That clear-cut trail is striking evidence that each lug on the proved o-p-e-n c-e-n-t-r-e tread is doing its job 100 per cent. every time it comes round — penetrating full depth into the earth with a definite thrust and so giving maximum grip and pull.

For getting *more* work done *faster* Goodyear Sure-Grip Tractor Tyres are the right choice every time.

GOODYEAR

SURE-GRIP TRACTOR TYRES

Please mention the JOURNAL *when corresponding with Advertisers*

Please mention the JOURNAL *when corresponding with Advertisers*

Please mention the JOURNAL *when corresponding with Advertisers*

72-1-7-48

Agriculture

PUBLISHED 6d MONTHLY

# AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

Editorial Offices: St. Andrew's Place, Regent's Park, N.W.1 (*Phone* : *WELbeck* 7711)

VOL. LV No. 5 AUGUST 1948

Contents

Cover Photograph

Corn Harvesting, Derwentwater .. *G. Bertelsman*

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LV No. 5 AUGUST 1948

CALF REARING

PROFESSOR E. J. SHEEHY

A paper read to officers of the Ministry of Agriculture at Harper Adams College, April 15, 1948.

THE type of animal into which a calf grows is determined by its genetic constitution, but the expression of the genetic potentialities is, however, determined by the feeding of the animal and to a less extent by its management and the conditions under which it lives.

Pre-Natal Life The feeding or nutrition of the calf begins in the uterus of its mother. Indeed nutrition determines to an extent whether or not the calf comes into existence at all. For instance, in the cow or heifer whose diet is seriously deficient in phosphate, cobalt or other essential minerals, the Graafian follicles of the ovary may fail to ripen at the normal time, oestrus, with the possibility of conception being deferred temporarily, if not indefinitely. In the uterus the calf is fed from the mother's blood, diffusion from which into the blood of the calf takes place through the placental membranes. These membranes are pervious to gases and to all the nutrients required by the developing calf.

Inadequately fed pregnant animals bring forth normal offspring by the expedient of sacrificing their own bodies. In modern cattle husbandry, however, this cannot be relied on to produce calves with the strength and disease resistance necessary for success in calf rearing. A 75-80 lb. calf at birth contains about 20 lb. of dry matter, and of this the greater part is accumulated during the last third of pregnancy, which, of course, is the important period in as far as the extra feeding of the pregnant cow or heifer is concerned. A serious deficiency, during this period in particular, of the food nutrients required by the developing foetus is reflected in the condition of the calf at birth. Such a deficiency may occur with the vitamins and minerals, but very seldom arises in as far as protein or total calorific requirements are concerned. Cows suffering from a chronic deficiency of phosphate in their diet give birth to weak calves ; similarly the calves from cows whose diet provides inadequate iodine may be born dead or goitrous ; and cows whose food intake during pregnancy is seriously deficient in vitamin A or carotene produce weak calves which are highly susceptible to scour and pneumonia and among which casualties are numerous. Obviously there is a limit to the efficacy of the maternal instincts to denude the body of the pregnant mother in the interests of the developing calf in the womb.

The occurrence of aphosphorosis* in a few areas in Ireland adversely affects the condition of newly-born calves in these areas, causing serious debility. Weakness and high susceptibility of the newly-born calf to disease arising from an insufficiency of vitamin A in the mother's diet also occurs in

* Phosphate deficiency.

parts of Ireland, and, perhaps in Britain too. The newly-born calf usually has a low blood vitamin A content with very little vitamin A in its liver. There is evidence, however, that both of these can be increased by the feeding of massive doses of vitamin A or carotene to the pregnant mother prior to parturition or by feeding vitamin A to the calf at birth. There is also definite evidence that the health and resistance to disease of a calf is closely related to the vitamin A or carotene intake of the pregnant mother. On some Irish farms where the diet of the cows over the winter is composed chiefly of hay, and that not of best quality—a diet highly deficient in vitamin A—calf mortality from scour and pneumonia is very high, but when good grass silage, with its high carotene content, replaces part of the hay in the mother's diet the record of calf rearing becomes a much more cheerful story. I have experienced cases where the calves scoured from birth, no doubt due to poverty of vitamin A, a condition reported as having been produced experimentally by American investigators. The feeding of pregnant cows with materials rich in vitamin A or carotene, namely, pasture grass, green forage crops, silage, and good quality hay, is accordingly a matter of considerable importance in as far as the pre-natal nutrition of the calf is concerned.

Post-Natal Life Referring back to the placenta, it is found that this organ is, in the case of cattle and sheep also, only very slightly permeable to those blood anti-bodies which help to confer immunity to a variety of diseases. Consequently the calf is born with a very low concentration of these anti-bodies in its system, and this fact brings one to the consideration of colostrum or beestings. The merits of beestings are perhaps best known to the shepherd, who regards the udder of the mother as a medicine chest for the newly-born lamb. The cow's colostrum is equally useful to the calf, and the rearing of an animal which receives the colostrum is a far easier proposition than is the rearing of one which does not receive it. Being exceedingly rich in the anti-bodies, the colostrum provides the calf, within a day or two, with a degree of resistance to diseases comparable with what the animal would otherwise accumulate in weeks or perhaps months. The calf, unlike certain other animals, the puppy for instance, is dependent on colostrum for these anti-bodies. As a source of vitamin A colostrum is equally important to the calf. Its ingestion is followed by a marked increase in the vitamin A content of the calf's blood. Globulin, which serves important functions particularly in early life, and to which the alimentary tube of the calf is at any rate partially permeable, is richly supplied by colostrum, and this, because of its laxative effect, also dislodges faecal residues from the lower gut of the calf. Another important merit of this first milk of the cow is connected with the type of curd formed by colostrum in the stomach of the calf, a curd which is digested with the greatest facility.

Rennet Curd This brings one to the important matter of digestion in the stomach of the calf during the period while milk passes directly into the fourth stomach and prior to the assumption of function by the first, second and third stomach compartments. The curding of milk in the stomach of young mammals takes place as a result solely of rennet action, rather than as a result of acidification, a process which supplements or replaces rennet action in adults. Now the type of milk curd produced by rennet varies with the different species of mammals. It is dense in the case of the milk of the cow, sheep and goat. It is, in comparison, open and light in the case of the milk of the mare, ass, dog, pig and human. The open curd is much more easily penetrated by the stomach juices than is the dense curd, and consequently, the digestion of the open curd by the pepsin of the digestive

juices goes on with greater facility than in the case of the dense curd. This natural difference in curding is related to the proportion of casein to the albumen and globulin in the protein of milk. Rennet coagulates milk into a dense curd when the proportion of casein to albumen and globulin is high: it coagulates milk into a less dense and more open curd when the proportion of casein to albumen and globulin is lower. The milk of the cow, sheep and goat has a casein to albumen and globulin ratio which is higher than that of the other species mentioned above and hence the difference in the type of curd produced. A foal or a bonham or a baby fed on cow's milk is accordingly placed at a disadvantage in as far as stomach digestion is concerned in comparison with one given the milk of its own species. In connection with this matter of curding the colostrum from the cow (and sheep and goat) is akin to the ordinary milk of the other species mentioned, in that, because of its comparatively low casein to albumen and globulin ratio, it gives an open, easily digested coagulum or curd for rennet digestion. Furthermore the curd produced in cow's milk from early lactation is less dense and more easily digested than that produced in milk from late lactation.

Nutritional Scour I have dealt at length with this matter of the type of curd because of its close connection with what I call nutritional scour which occurs in the case of pail-fed calves during the first two or three or perhaps four weeks of life, and which is responsible for many casualties and for a considerable amount of unthriftiness in calves. Under natural conditions a cow suckles her calf a considerable number of times per day. Under pail-fed conditions the calf ingests in two feeds what it would otherwise take into its stomach in a dozen or more feeds. In order to make the desired progress a calf would require to drink the following quantity of milk during the first three weeks of life :

1st week	6	pints	increasing	to	8	pints daily
2nd ,,	8	,,	,,	,,	10	,, ,,
3rd ,,	10	,,	,,	,,	12	,, ,,

Now when a week-old calf fed twice daily takes half a gallon of milk into its stomach quite a large clot is developed. It is gradually digested but if, as a result of slow digestion, any curd remains in the stomach on the arrival of the next feed of milk the residue forms a nucleus round which the new curd accumulates. A continuation of this process may cause an increasing accumulation of curd which (and this is important) is continuously subjected to the squeezing action of stomach peristalsis. The curd is thus hardened and rendered more difficult of digestion and so the train of consequences may continue till, in the course of a few days, the calf, because of abnormal curd accumulation in its stomach, is seriously ill. It loses appetite, becomes dull with drooping ears, and begins to scour. The diarrhoea is caused by gastro-intestinal reflex action, the chronic irritation of the stomach caused by the persistent curd stimulating, as in the case of parasitic gastroenteritis, violent peristalsis of the lower gut with consequent diarrhoea. Weakness follows the scour and, unless relief is forthcoming, death occurs.

Relief from this condition is a matter of the removal of the offending curd, a process which can be effected in either of two ways : (1) the dissolving of the curd in the stomach by a strong chemical which would at the same time eat away the stomach lining, and (2) by providing the natural solvent of the curd, namely the digestive pepsin of the stomach, with the opportunity to serve its function. To allow No. (2) to operate, the feeding of milk must cease for the time being, and its place must be taken by the fluid which is

most conducive to rapid pepsin action in the stomach—namely, plain water. For obvious reasons the water should be boiled and cooled to body temperature. At the commencement of treatment of cases of scour it is always advisable to give a dose of castor oil, lest some irritant in the intestine may require to be dislodged, the dose being 1 oz. in the first week, 1½ oz. in the second week and 2 oz. in the third week of life.

In Ireland scouring was a major difficulty in calf rearing on many farms until its cause was connected with incorrect feeding as a result of experiments conducted at University College, Dublin, some few years ago. We carried out investigations to the extent of being able to reproduce at will this condition of nutritional scour. Twice-a-day feeding with undiluted milk from the mixed milk of the herd, especially when a fair proportion of the cows were in late lactation, provided the conditions for nutritional scour to occur. Calves responded differently, however. Some developed the disorder when the intake of undiluted milk was even less than the daily quantity specified above as essential for good progress: others remained healthy till the daily milk consumption in two feeds considerably exceeded the normal daily allowance. Apparently calves, like ourselves, vary in the ability of the stomach to digest food. In all cases of nutritional scour calves showing various stages of distress, from mere disturbance of appetite to extreme prostration, responded to the simple water treatment. If the appetite still remained they were fed water instead of milk; if the animals were past the stage of taking food, then water was administered to them. In cases of extreme weakness water was administered in half-pint doses every two hours: in less extreme cases larger quantities of water were administered less frequently and in still less extreme cases water was simply given to drink instead of the usual feed of milk. After twenty-four hours of this treatment recovery took place in all cases, whereas calves which continued to receive undiluted milk developed more and more severe symptoms, and weak ones to which milk was continued to be administered died. The diet of water was followed up after twenty-four hours by a mixture of equal parts of milk and water and then by water 1 part to milk 3 parts till in a few days complete recovery was effected.

Prevention of nutritional scour or diarrhoea arising from nutritional causes in early life in the case of calves pail fed twice daily consists in diluting the milk feed with boiled water so as to render the milk curd formed in the stomach less dense and easier of digestion. The necessity for taking such precautions is less when a calf is fed its own mother's milk or the milk from a cow calved about the same time than it is when the calf's milk is supplied by a cow in late lactation or from the mixed milk of the herd. Similarly when a calf is fed three times per day the necessity to dilute the milk with water arises to a much less degree because of the smaller quantity of milk taken at each feed by the animal fed thrice daily. Three-times-a-day feeding of the calf for the first three or four weeks of life, while practicable, is however too much to ask of farmers in these days of expensive labour. The addition of half a pint of water at each feed and as regular routine practice is accordingly recommended. As already indicated some calves do not require to have their milk diluted, but when fed twice daily the majority do. Actually we have in our experiments fed calves which during the first fortnight of life were not able to tolerate milk till it was diluted to the extent of 50-50 with water. The adoption of this simple preventative treatment for scour has been of considerable help to our farmers, and many of them who previously found it impossible to rear calves profitably are now experiencing no difficulty from scour. They say that the dilution of the milk has removed the worry from calf rearing.

Of course there are other causes of scouring in calves such as feeding from unclean vessels, irregularity in the temperature of the milk fed, the giving of sweet and sour milk alternately, etc. In addition there is the contagious type of scour, the organisms causing which enter the body of the calf through the navel immediately after birth, or, subsequently, via the mouth should the walls, partitions, or doors of the calf-house harbour the germs of the disease voided by infected calves previously housed in the same compartment. The precautions to be taken against scour arising from these various causes are, of course, a matter of hygiene coupled, where contagious white scour occurs, with the iodine treatment of the calf's navel immediately after birth. Contagious white scour occurs in Ireland only in the warm early summer months ; the incidence of it is indefinite and scouring from this cause is very frequently confused with scouring from nutritional causes.

Even in the case of scour of the non-contagious type, the immediate cause of death is associated with the invasion of the tissues by pathogenic organisms from the alimentary tube. There is a certain amount of evidence to the effect that when the body resistance is low the ordinary saprophytic germs of the intestine of the coli type may become pathogenic. Hence the advantage of taking measures to increase the disease-resisting powers of the calf's body and of avoiding anything which would predispose the body to disease. The feeding of colostrum is important in regard to the former, and the dilution of the milk of pail-fed calves and the accommodation of the animals in well-ventilated, cool compartments free from draughts are similarly important in regard to the latter. Where colostrum is not available it is advisable to give newly-born calves an ounce of castor oil to stimulate evacuation, and during the first few days of life, to supplement each feed with a couple of teaspoons of veterinary cod liver oil in order to raise the vitamin A of the calf's blood.

Rearing when Separated Milk is Available Milk is the best of all foods for the young calf, and for the first three or four weeks of life it is difficult to replace it by any other food or combination of foods. To start with, the dry matter of milk is practically 100 per cent digestible. Milk contains proteins which supply all the amino acids necessary for health and rapid growth : similarly it contains the minerals in quantity and proportion just right for the calf's requirements, and in addition to B_1 and B_2 group of vitamins, it is fairly rich in vitamins A and D. Furthermore its carbohydrate content is in the form of sugar, a point of significance in view of the inability of the pancreatic juices to digest starch till the calf has reached the age of a couple of weeks. The B_2 group of vitamins which are synthesized by ruminents must be supplied with the food to calves till such time as the function of rumination is well established. Theoretically a milk substitute may be prepared, though it is not yet certain whether there may not be some still unidentified but essential nutritive factors in milk. Apart from this possibility, however, the preparation of a suitable milk substitute for the calf during its very early life is so difficult and expensive that, in present circumstances at any rate, it would appear to be true to say that a certain amount of whole milk is essential for the successful rearing of the calf. In Ireland we feed about 35 gallons of whole milk per calf, but then separated or skim milk is usually available and the feeding usually follows the following lines :

1st week of life	6 pints increasing to		8 of whole milk	
2nd ,, ,, ,,	8 ,, ,, ,,		10 ,, ,, ,,	
3rd ,, ,, ,,	10 ,, ,, ,,		12 ,, ,, ,,	
4th ,, ,, ,,	8 ,,	whole milk and	4 pints separated skim	
5th ,, ,, ,,	4 ,,	,, ,,	8 ,, ,, ,,	

6th week of life	2 pints whole milk and	10 pints separated skim
7th ,,	,, ,,	12 ,, ,, ,,
8th ,,	,, ,,	12 ,, ,, ,,
9th ,,	,, ,,	12 ,, ,, ,,
10th ,,	,, ,,	12 ,, ,, ,,

Thenceforward separated milk in smaller or larger quantity as available.

Dry meals, in addition to hay, are introduced in the third week, the calf being fed more or less to appetite, so that by the eighth week it is consuming about 2 lb. per day of meals. Under these conditions of feeding the choice of meals is not a matter of serious consequence because the separated milk, while available, and good hay provide the necessary minerals, vitamins, and proteins. With these foods bruised oats alone is satisfactory, a mixture of oats with barley or maize gives a better conditioned calf, while the addition of linseed cake adds to the appearance of the calf, giving the condition of bloom so much admired by stock owners.

Rearing when Separated Milk is not Available When separated milk is not available the extended feeding of whole milk may commend itself in certain circumstances, but not so where whole milk sells at a high price for the liquid milk trade. The problem of calf feeding in these circumstances becomes more complex. However, by the end of the third week rumination has usually begun and the calf can synthesize certain vitamins, and starchy foods can be efficiently digested in the third stomach so that from there on milk substitutes may be freely introduced. There is, however, still one difficulty—the fact that the calf will not at this tender age consume sufficient dry matter in the form of dry meals and hay or other fodder to provide the nutrient requirements for normal growth. For reasons of economy the whole milk must be reduced in the fourth, fifth and sixth weeks as shown above, and a supplement of cooked meals, which calves freely consume, introduced. The cooking of meals for calves is, however, troublesome as well as expensive, so that it is advisable to reduce the period of cooked meal feeding to a minimum. Beginning in the fourth it may terminate in the eighth week, a reasonable allowance being 1-1½ lb. per day, i.e., 1-1½ lb. of dried meals fed in the cooked form. Dry meal feeding would, of course, continue at the same time so that by the eighth week of age the calf would be consuming 3-3½ lb. of meals, 2 in the dry and 1-1½ in the cooked form. Thenceforward 3 lb. decreasing to 2 of dry meals daily, together with hay or other fodder or pasture grass, makes a satisfactory diet. The daily schedule of milk and meal feeding thus becomes :

1st week	6 pints increasing to 8 of whole milk	
2nd ,,	8 ,, ,, ,, 10 ,, ,, ,,	
3rd ,,	10 ,, ,, ,, 12 ,, ,, ,,	and dry meals
4th ,,	8 pints whole milk and	1 lb. cooked meals together with dry meals
5th ,,	4 ,, ,, ,, ,,	1 to 1½ lb. cooked meals together with dry meals
6th ,,	2 ,, ,, ,, ,,	1 ,, 1½ ,, ,, ,, ,, ,, ,,
7th ,,		1 ,, 1½ ,, ,, ,, ,, ,, ,,

Thenceforward 3 lb. of dry meals reducing later to 2 lb. per day. The dry meal consumption would be more or less negligible in the third week, would remain still low in the fourth week, but would increase to about 2 lb. a day in the seventh to eighth week.

A calf fed as above would consume approximately 35 gallons of whole milk. This amount may be reduced to 30 gallons by increasing the quantity

of cooked meals, when the following schedule of feeding would apply:

1st week	6 pints whole milk increasing to	8 pints	
2nd ,,	8 ,, ,, ,, ,,	,, 10 ,,	
3rd ,,	10 ,, ,, ,,	and ½ lb.	cooked meals together with dry meals
4th ,,	6 ,, ,, ,,	,, 1¼ ,,	,, ,, ,, ,, ,,
5th ,,	2 ,, ,, ,,	,, 1½ to 2 lb.	cooked meals together with dry meals
6th ,,	1 ,, ,, ,,	,, 2	,, ,, ,, ,, ,,
7th ,,		2	,, ,, ,, ,, ,,

Thenceforward 3 lb. of dry meals reducing later to 2 lb. per day.

In the absence of separated milk or separated milk substitute, the constitution of the meal portion of the ration must, for obvious reasons, receive particular attention. In such circumstances I have found the following formulæ suitable:

Cooked Meals

Finely ground oats and/or barley and/or maize and/or wheat	1 stone
Oatmeal	1 ,,
Linseed meal	1 ,,
Ground limestone	1 lb.
Salt	½ ,,

Dry Meals

Rolled or bruised oats	4 stone
Coarsely ground barley or maize or pollard	2 ,,
Linseed cake	¾ ,,
Meat and bone meal	¾ ,,
Salt	1 lb.

A little cod liver oil in the fourth and fifth week, while not essential, ensures against a shortage of vitamin A and reduces the susceptibility to pneumonia.

As already mentioned the choice of meals for calves, at any rate from the point of view of chemical composition, does not give much cause for concern while an adequate allowance of whole or separated milk or milk powder is available. The withholding of milk marks a critical period in the life of the calf however. The meals must then supply the extra protein and minerals required for growth. A mixture of cereals or cereal offals together with oil cake, while providing the calorific food nutrients and protein, is in that set of circumstances seriously deficient in minerals for calves. Actually a good deal of the unthriftiness among calves up and down the country is due to a deficiency of minerals in their diet at the weaning stage. This obtains particularly among house-fed calves but it applies to calves on pasture also, because, notwithstanding the richness of pasture herbage in minerals, the amount of it consumed in early life is inadequate to provide the full mineral requirements of the calf. Fish meal and meat and bone meal are exceedingly useful dietary supplements for the weaned calf, both being rich sources of protein and calcium phosphate. When meat and bone meal is used the addition of a little salt to the diet serves a useful purpose. A calf, whether confined to the house or out on pasture, should receive 2 lb. per day of meals till it is six months of age.

The young calf doesn't take seriously to grazing till it is five weeks of age, prior to which it is better off in a suitable house than out-of-doors. Hay is an excellent food to induce the calf to cud, and it is good practice to allow the animal access to hay in the third week of life. If confined to the house, and given a couple of pounds of meals per day, it will eat ½ lb. of hay per day in the fourth week, 1 lb. in the seventh, 2 lb. in the twelfth, 3 lb. in the fifteenth, 4 lb. in the nineteenth and 7 lb. daily in the 26th week of life. The best hay, i.e., the earliest cut and greenest sample of hay on the farm, should be reserved for the calves, to which it acts as a good source of protein, minerals, including calcium and salt, vitamin A and vitamin D, as well as of digestible carbo-

hydrates. House-fed calves relish a little pulped roots, taking about a ¼ stone per day at 6 weeks of age, increasing to ½ stone per day at 12 weeks. Silage may partly or wholly replace the hay and roots from the eighth week, and some fresh green food such as cabbage provides variety and ensures against nutritive deficiency.

A reasonably well-fed, healthy calf should reach a live weight of at least 3 cwt. at 6 months of age.

Accommodation The most hygienic place for a calf to be born is in the open field. It is excellent practice to clean out, wash and disinfect the calf-house or houses once a year and the disinfection process is essential where such diseases as joint-evil or contagious white scour or contagious pneumonia lurk. Ordinarily, however, such scrupulous cleanliness in the house is more a counsel of perfection than part of farming routine. I favour the type of house where the calves are kept communally and the front of which is fitted with bales in which the animals are tied up at feeding and for some time thereafter. Close conditions leading to a stuffy atmosphere in the calf-house is conducive to ill-health. There should be sufficient ventilation to prevent the air in the calf-house from getting any warmer than the outside atmosphere. Calves which are out by day and in at night in a stuffy house develop a chill of greater or lesser intensity on going out every morning; they thus become predisposed to pneumonia. A calf-house need not be an expensive building; in fact the simple structure with a half-built-up wall on one or two sides may be more favourable to good health than a palatial building.

In the case of calves on pasture, the loss from unthriftiness caused by vermin infection is far greater than it should be. Husk has become a very serious disease, in the case of which even the best-known treatment is not very satisfactory. Accordingly the adoption of methods of prevention—namely, the provision for calves of clean worm-free pasture, the housing of the animals from late summer, and liberal feeding—is of more than usual importance in the case of this disease. Parasitic gastro-enteritis, while subject to control by the regular administration of phenothiazine, does much injury before its presence is suspected, and hence in this case also the value of clean vermin-free pastures for calves. Very often the calf paddock next to the house which has had a concentration of older stock at various times of the year is the worst possible field on the farm to accommodate calves.

Suckled Calves Time permits only of a short reference to suckled calves. The number suckled by a cow obviously depends on her milk yield, but it is a bad cow which is not capable of feeding two calves. Personally, I see no place on the commercial farm for the strain of cattle which, notwithstanding length of pedigree or the price paid for the sire or dam, or the excellence of quality of its beef carcass, continues to exist by the assistance of the nurse cow, the mother being unable to provide sufficient milk for its own calf. While a beef cow should rear two or three calves during the lactation period, a good dairy cow yielding over 4 gallons a day will rear four calves at a time. During her lactation a cow, according to her milk yield, will rear from one to a considerable number of calves—six, eight or even ten. When there are more than two being fed at a time it is essential to keep the cow and calves apart and to allow her to suckle them at intervals. There is just one point I should like to make in connection with this method of rearing, namely, the possibility of nutritional scour. Late lactation milk produces in the calf's stomach a denser curd than milk from the same cow in early lactation. For this reason nutritional scour may possibly develop when a cow in late lactation is put to suckle a newly-born calf. When, there-

fore, calves are being weaned from a cow and fresh calves are about to be introduced, the most dilute of the milk must be given to the fresh calves by allowing them to take the first milk from the udder at each feeding, the older calves, which are to be weaned, following up and emptying the udder. Because of this difficulty with the curd of milk from cows in advanced lactation, it is good practice, when replacing calves under a cow, to have the fresh calves a couple of weeks old rather than newly born.

FARM-STORED GRAIN

T. A. OXLEY, B.Sc., A.R.C.S.
Pest Infestation Laboratory, Slough, Bucks

THE combine harvester continues to spread throughout the country, but arrangements for dealing with the crop after it has been cut are generally not progressing as rapidly as new combines are coming into use. Hence a serious situation is developing.

There are two main problems. First, where are we going to put the threshed grain? The mills and merchants cannot possibly take in three or four weeks the grain supply which used to be spread over more than six months, and there is not enough transport to get all the grain off the farm in the time even if they could take it. Many farmers will thus have to find suitable accommodation for combine-harvested grain, at least for a few weeks and sometimes for much longer.

The second problem is that of the fitness of the grain for storage. Largely this is a question of moisture content, though some people believe that grain harvested by combine always gives more trouble in storage than grain of the same moisture content harvested by traditional methods. This may be true, though I know of no scientific evidence in support of the belief.

In most seasons grain comes from the combine at a moisture content far too high for safe storage, but we know that if it is properly and thoroughly dried, combine-harvested grain will keep in perfect condition, quite as well as grain threshed from the rick. No combine harvester should, therefore, be operated unless the owner has access to a grain drier. But there are many who neglect this advice and are relying on merchants or millers to take the grain off their hands before it has time to lose condition.

It is probably too late for farmers to make proper provision for grain storage this season if they have not already done so, but it may be possible to avoid the worst troubles by taking suitable precautions. The main purpose of this article is to make some "first aid" suggestions for immediate application; but a second purpose is to make some suggestion to owners of driers and to those who may be contemplating improvising alternative storage methods in time for next season.

Cut the Grain in the Best Possible Condition The most useful action which a farmer can take to safeguard his grain is to let it reach the best possible condition in the field before cutting it. Harvesting by combine should be postponed until about a fortnight after the crop would be judged fit for reaping and binding. If

drying and storing facilities are at fault the crop is probably safer standing in the field for even longer than this than it would be in the threshed state under cover.

It is worth every effort to avoid morning dew by postponing the start of cutting until the ears are thoroughly dry, even if this means waiting until noon or later. Similarly, if harvesting must be done in the intervals between showers, leave as long as possible after each shower before cutting, especially if there is little wind or sun.

Precautions of this sort are possible only if the harvesting equipment is ample for the area to be covered so that the entire crop can be cut in relatively few working hours. For this reason one of the best ways in which money can be spent to keep grain in first-class condition is to buy combine-harvesting equipment of ample size so that the grain is in the best possible condition when the storage period begins.

There is sometimes an advantage in keeping separate any bags cut from a part of the field where the grain is likely to be less dry or ripe than the average. Such parts are usually the edges of the field, especially if they are close to large trees or bushy hedges, or any areas where soil conditions tend to delay development of the crop. Grain from these areas should be given priority for drying.

Efficiency in Drying If a drier is available it is worth taking the greatest care to operate it as efficiently as possible, but it is no use saving grain from deterioration in store if severe damage is caused by overheating in the drier. It is absolutely essential that the maximum air temperatures recommended by the Ministry of Agriculture are not exceeded, even for a moment. These temperatures are:

	Degrees F.
Wheat for milling	150
Barley and seed corn up to 24 per cent. moisture ...	120
Barley and seed corn above 24 per cent. moisture ...	110
Linseed, mustard and other oily seeds	115
Oats and dredge corn, except for seed	180

The rate of drying increases as the air temperature is raised, so that the aim should be to keep the air temperatures as close *below* the above temperatures as possible. Any temptation to exceed them must be resisted. Barley or milling wheat will be ruined, as the maltster or miller will discover at once when he begins to use it, and a few experiences of this sort will quickly prejudice him against farm-dried grain. Goodwill lost in this way is difficult to regain. The best safeguards are thermostatic control and close supervision. Also, it is very useful to install an automatic temperature recorder, so that a record can be shown to the buyer of the grain.

It is equally dangerous to increase the rate of air flow through the drier, for the above temperatures are air temperatures only. It would cause serious damage if the grain itself got as hot as this, as it would tend to do if very high air velocities were used.

If the drier cannot deal with all the grain which needs drying within a few days, it is best to run all the grain once through the drier very quickly, and complete the drying at leisure later. Grain which has been dried from say 24 per cent moisture content to 20 per cent will generally keep better than grain which was initially at 20 per cent moisture content. If the weather is cool it will probably keep for a fortnight to three weeks without appreciable damage, during which time it should be possible to re-dry the whole stock to 16 per cent or less for safe storage throughout the winter.

Bag Storage If damp grain must be stored bags are preferable to ordinary bulk storage because of the ventilation which they give, although bulk bins equipped for forced ventilation are probably preferable to either.

To get the best ventilation, bags should be stood vertically, with as much space between them as the area of the floor permits; stacking bags closely is little better than a bulk. Some people advocate leaving the tops open, but it is doubtful whether this has much effect on ventilation. It is an advantage to move bags every few days so that fresh parts of them are exposed to the air.

If there is enough space grain may be spread over the floor in as thin a layer as possible, but it will probably be no advantage to adopt this very laborious procedure unless it can be in a layer not more than 6 inches thick. If the layer is likely to be thicker than this the grain is probably better left in bags.

Any concrete, brick, stone or earth floor which lies directly on the soil, unless it has an effective damp-course, is continually passing water vapour to the atmosphere, however dry it may look. Such floors should be avoided for standing bags or spreading out grain, for when the floor surface is covered by grain, soil water passes directly into it through the pores of the floor. It is better to store grain on an upper floor wherever possible.

Drying by Admixture It is sometimes possible to deal with small quantities of unusually damp grain by mixing it intimately with a larger quantity of dry grain or with some other absorbent material which can be removed subsequently. For this purpose mixing must be very thorough, such as is secured by mixing alternate shovelfuls of the dry and damp material; it is not good enough to mix by sackfuls. If this procedure is adopted it is essential to use sufficient of the absorbent material; otherwise it is a waste of labour.

When mixing extra damp grain with dry grain the quantities should be in the ratio of at least 3 or 4 of dry grain to 1 of damp. If the approximate moisture contents are known it is worth making a rough calculation to see whether the proposed treatment will work. Thus, if grain at 24 per cent moisture content is to be mixed with grain at 15 per cent moisture content, and the mixture must not be allowed to rise higher than $16\frac{1}{2}$ per cent, the former must give up $7\frac{1}{2}$ per cent while the latter absorbs only $1\frac{1}{2}$ per cent. The quantities must therefore be in the ratio of $7\frac{1}{2} : 1\frac{1}{2} = 5$ to 1, i.e., 5 shovelfuls of dry grain to 1 of damp.

Other materials which have from time to time been used in emergency and might be tried again are: chaff, chopped straw, peat, sawdust, small pieces of wood, ashes, and lime. It will usually be necessary to have a weight of absorbent four or five times that of the grain to be treated, unless the absorbent is very dry indeed. Freshly burnt lime, however, will absorb one-third of its weight of water and should need to be used only at the rate of one-fifth to one-tenth of the weight of damp grain, but I am not aware of any practical case in which it has been so used.

Bin Ventilation If bulk storage is available forced ventilation of the grain is worth serious consideration. It will completely prevent spontaneous heating and will prolong the period of safe storage by several days or weeks. It will not usually serve as a substitute for drying, however, for sooner or later damp grain becomes musty and loses its germinating power in our climate; although if the grain is only slightly above the normal limit for storage, it may sometimes be kept safely by ventilation alone until early summer.

Bin ventilation requires an air blower and a means for distributing air at the bottom of the bin. The latter may consist of one or more Λ shaped ducts fixed across the bottom of the bin an inch or two above the floor, but alternatively the bin may be given a false bottom of foamed slag blocks or of wooden slats nailed one-eighth of an inch apart, air being blown into the space between the true and false bottoms. In either case the true bottom must be airtight. Ducts of the Λ type should be not more than 4 feet apart.

The grain should be kept as shallow as possible, preferably not more than 15 feet deep. The minimum quantity of air required is about 3 cubic feet per minute per square foot of bin floor. The pressure required will be approximately proportional to the depth of the grain and will be about 1 inch water gauge for a depth of 10 feet. Very approximately each 20 tons of grain requires about one horse-power to ventilate it adequately, though good design can reduce this requirement.

Drying in the Bin In the British climate bin ventilation does not usually dry the grain, unless the air is slightly warmed. With a suitable design it is possible to dry grain completely in this way, thus combining drying and storage most conveniently. This method is still experimental but with care there is no reason why those farmers who have the facilities should not try it.

The chief danger is that the upper layers of grain will remain damp for too long while warm wet air blows over them. This danger is minimized by keeping the grain depth small and the air velocity reasonably high. In practice 10 feet is about the maximum depth which can be allowed in bin drying and an air velocity of 4 or 5 cubic feet per square foot of bin floor is required at that depth, but if the depth is reduced the necessary volume of air is reduced in approximately the same proportion with considerable economy in power.

Theoretically the air should be warmed by an amount varying according to its original humidity and temperature, but the simplest practical arrangement is to heat the air to a constant amount above its incoming temperature. It should not be necessary to heat it more than 14° F., and less should be sufficient. Drying should be completed in 7 to 14 days.

It is a great advantage in bin drying (and also in bin ventilation) to turn the grain at least once during the period of treatment. This minimizes the development of mustiness in bin ventilation or of deterioration of upper layers in bin drying. The more frequently grain can be turned over in this way the greater the depth that can safely be dried.

Some further information on bin ventilation and an account of some early experiments in bin drying are given in a pamphlet entitled *Bin Ventilation* (1945), *Storage and Drying of Grain in Bulk,* published by H.M. Stationery Office in 1947, price 9d. (10d. by post).

(Mr. Oxley's recent book, *Scientific Principles of Grain Storage*, is reviewed on p. 229.—Editor.)

CELERY "BLIGHT"

THE NEED FOR CLEAN CELERY

R. Eric Taylor, B.Sc., Ph.D.
and
W. A. R. Dillon Weston, M.A., Ph.D.
National Agricultural Advisory Service, Eastern Province

FOR many years the eastern counties have been the principal celery-growing area in this country. In 1946 the acreage amounted to 4,998, and in 1947 to 4,337. Of this, 3,276 and 2,705 acres were grown respectively in Norfolk and the Isle of Ely. The black organic soils and the high water-table of the Fens are especially favourable for celery, and excellent crops can be obtained. Often, however, Celery Leaf Spot, or "blight" as the farmer calls it, appears, impairing marketing quality and reducing yields, or even causing total loss of the crop.

Seed-borne Fungus Leaf Spot was first recorded in Britain in 1906 by Chittenden(1) on a celery plant received from Colyton, S. Devon, but it is possible that the disease was present earlier. It was soon recognized that the fungus could be carried on the seed, for in 1911 Klebahn, working in Germany, showed that washings from seeds saved from diseased plants contained the spores of Leaf Spot, and he expressed the view that the sowing of seeds containing the spores of the fungus was the principal, if not the only, means of distributing the disease. In 1911 Chittenden(2) examined thirty-three samples of celery seed and found that fourteen contained the spore cases of the fungus on the seeds or pieces of stalk mixed with them. Similarly, in 1927 Stirrup and Ewan(5) observed that, "on the surface of the fruit and on the stalk, which often remains attached to it, the black spore cases of this fungus are often found ; indeed one might be justified in saying, always found".

During 1931-32, at Manchester University, Holmes Smith(3) found that the percentage of infected seeds in samples of local seed varied from 5 to 83 per cent. Less than half of the samples showed an infection of below a mean of 40 per cent, and this was greatly exceeded by the majority of the remainder. In 1939 Lin in the U.S.A.(4) found on an average of nine counts that even a single spore case may contain 3,675 spores.

Although measures had been suggested by Stirrup and Ewan in 1927 for the temporary control of the disease by spraying the commercial celery crop, they considered that greater care should be devoted to the seed crops, and that "the best way to combat this disease would be to sow only clean, uninfected seed which would give rise to clean, healthy plants free from blight". It has long been known, however, that losses can be reduced considerably by disinfecting the seed with a weak solution of formaldehyde, and although Stirrup(5) recommended this in 1931, he concluded by saying : *"The production and use of clean seed free from infection is regarded as being logically and practically the only satisfactory solution of the Leaf Spot or 'blight' problem".*

It has been shown by Dillon Weston and Cronshey(6) that the production of clean seed is a practicable and commercial proposition. Starting with a seed crop in the autumn of 1945, at a time when every plant was severely infected, two sprayings with Bordeaux mixture were made. Fortnightly applications were started again from April, 1946, onwards to within 14 days of harvesting. As a result infection in the seed was reduced to ½ per cent at a cost of £5 for a total of 36 lb. of seed. If a crop is not too severely infected it is sometimes possible to produce clean seed by spraying only in

the second year. To grow completely clean seed, however, the seed crop should be sprayed regularly and thoroughly throughout its life. During the first year, the young plants should be sprayed twice after pricking out in the beds and then once a month in the field, or fortnightly if any Leaf Spot appears.

Despite the relative ease with which the disease can be controlled, little or no general improvement appears to have been made in the quantity of clean celery seed available in commerce, and many of the larger growers are now producing their own. During the last twenty-one years, 960 samples of celery seed have been examined for the presence of Leaf Spot at the Official Seed Testing Station, Cambridge ; of these only 12.8 per cent were free from infection, and in almost one-third of the samples 20 per cent or more of the seeds were infected.

Out of a total of 269 samples of celery and celeriac seed intended for export received at the Ministry's Plant Pathology Laboratory for the same period, and for which certificates of freedom from disease were required, spores were detected in the seed washings of 39.4 per cent of them, and such samples were rejected.

High Percentage of Infection shown by 1947 Survey

During recent years increasing concern has been evident among celery plant raisers and celery growers in the Isle of Ely at the continued destructiveness of the disease and the great difficulty in obtaining disease-free seed. In 1947, therefore, the authors made an independent survey of commercial celery seed as sold through the retail seedsmen throughout the country, to determine the extent to which supplies were infected Samples were bought at random from retail seedsmen ; neither vendors nor the immediate purchasers were aware of the purpose for which the seed was required. Altogether 106 samples were obtained, and these were examined by the same method as that used at the Official Seed Testing Station, Cambridge. One hundred seeds from each sample were placed on moist filter paper and each seed examined and turned under the microscope. When the number of infected seeds was 10 per cent or over, the percentage recorded was based on this first sample. When the infection was under 10 per cent an additional 150 seeds were examined and the percentage recorded on 250 seeds. The results of the survey are contained in the table below. Only 7 of the 106 samples received were free from infection, and the average infection in all the samples was 21 per cent. There was no indication of any correlation between the district where the seed was purchased and the amount of infection.

Percentage of infection	*Number of samples*	*Percentage o samples*
Nil	7	7
1– 9	29	27
10– 19	35	33
20– 29	12	11
30– 39	6	6
40– 49	0	0
50– 59	9	8
60– 69	7	7
70– 79	1	1
80–100	0	0

The records clearly show that there is considerable cause for disquiet at the extent to which celery seed supplies in this country are infected. Before there is any real prospect of an abatement in the large annual losses due to Celery Leaf Spot, there must be a markea improvement in the health of

commercial seed. It may be that the solution rests in the introduction of a voluntary certification scheme, whereby the seed crops may be certified as clean prior to harvesting. This, combined with an obligation on the part of the seedsmen to state the degree of infection in all celery seed sold, would do much towards ensuring that Celery Leaf Spot will no longer be a limiting factor in the production of healthy celery crops.

References

1. CHITTENDEN, F. J. Diseased Celery. Scientific Committee, November 20, 1906. *Proc. R. Hort. Soc.* (1907), **32,** 93.
2. CHITTENDEN, F. J. Contributions from the Wisley Laboratory. X.—Leaf Spot of Celery. *J. R. Hort. Soc.* (1911), **37,** 115-22.
3. HOLMES SMITH, E. Celery Blight Control (*Septoria-Apii* Bri. and Cav.). *Gdnrs' Chron.* (1933), **93,** 193.
4. LIN, K. H. The number of Spores in a Pycnidium of *Septoria-Apii*. *Phytopathology* (1939), **29,** 646.
5. STIRRUP, H. H. and EWAN, J. W. Report on Celery Blight and its Prevention. (1927, revised 1931). *Bull. Midl. Agric. Coll.*, No. 14.
6. DILLON WESTON, W. A. R. and CRONSHEY, J. F. H. Clean Seed—Clean Celery. *Agriculture* (1947), **54,** 322.

A HOME-MADE DUSTING MACHINE FOR RIDGE AND ROWCROP WORK

L. N. STANILAND, A.R.C.S., D.I.C. and J. MAYOR
National Agricultural Advisory Service, Bristol

A DESCRIPTION of two models of a home-made duster has already appeared in this JOURNAL*. Neither of these models can be used where crops are grown on the ridge. The machine described in this article has been devised to fill this need and has been so constructed that it can be used for rowcrop work either on the ridge or on the flat. The machine as constructed can be used over ridges or plants which do not exceed a height of 11 inches, and a very even cover of dust can be obtained. The machine is designed for the dusting of crops for flea beetles and certain other pests.

Space permits of only a short account of the construction of the machine, but the diagrams are largely self-explanatory. Making the machine involves little more than the straightforward use of wood, and nuts and bolts. The diagrams are not to scale.

Briefly the machine may be summed up as consisting of a rectangular framework. At the forward end there is a central area where a square wheel is mounted ; the machine runs on the square wheel and the rear ends of the sides of the rectangle. On either side of the square wheel is mounted a dust tray which may be raised or lowered. In each dust tray is an adjustable hessian dusthopper. The bumping action of the revolving square wheel shakes the dust from the hoppers and, since these hoppers are slightly longer than the side of the square wheel, the result is a continuous line of dust.

* STANILAND, L. N. and MAYOR, J. : "A Home-made Dusting Machine". *Agriculture*, **54**, February, 1948. Now available in leaflet form free from the Ministry, 1-3 St. Andrew's Place, Regent's Park, N.W.1.

The machine may be drawn by horse or tractor. Plate 2, Fig. 3 is a front view of the machine and shows the left-hand dust tray adjusted to go over a ridge ; the right-hand tray has been lowered for dusting on the flat.

Framework The plan of the machine is shown in Plate 1, Fig. 1. The framework is actually made of 3-inch × 2-inch wood quartering, but metal could be used. The width of the frame for 27-inch rows is 4 feet 6 inches, the machine dusting two rows at a time. The length of the frame is 8 feet 6 inches. The rear ends of the frame run between rows and are provided with short metal skids. The proper action of the machine depends on the rear sliding firmly on the soil whilst the fore-part bumps up and down. A box 1 foot wide and about 6 inches deep runs from one side of the frame to the other and is provided so that soil in bags, or some other weighting material, may be placed there to steady the machine. A reserve supply of dust can be carried in the box to facilitate refilling the hoppers. Note that the box is raised by extra blocks of wood to give equal clearance with the rest of the machine.

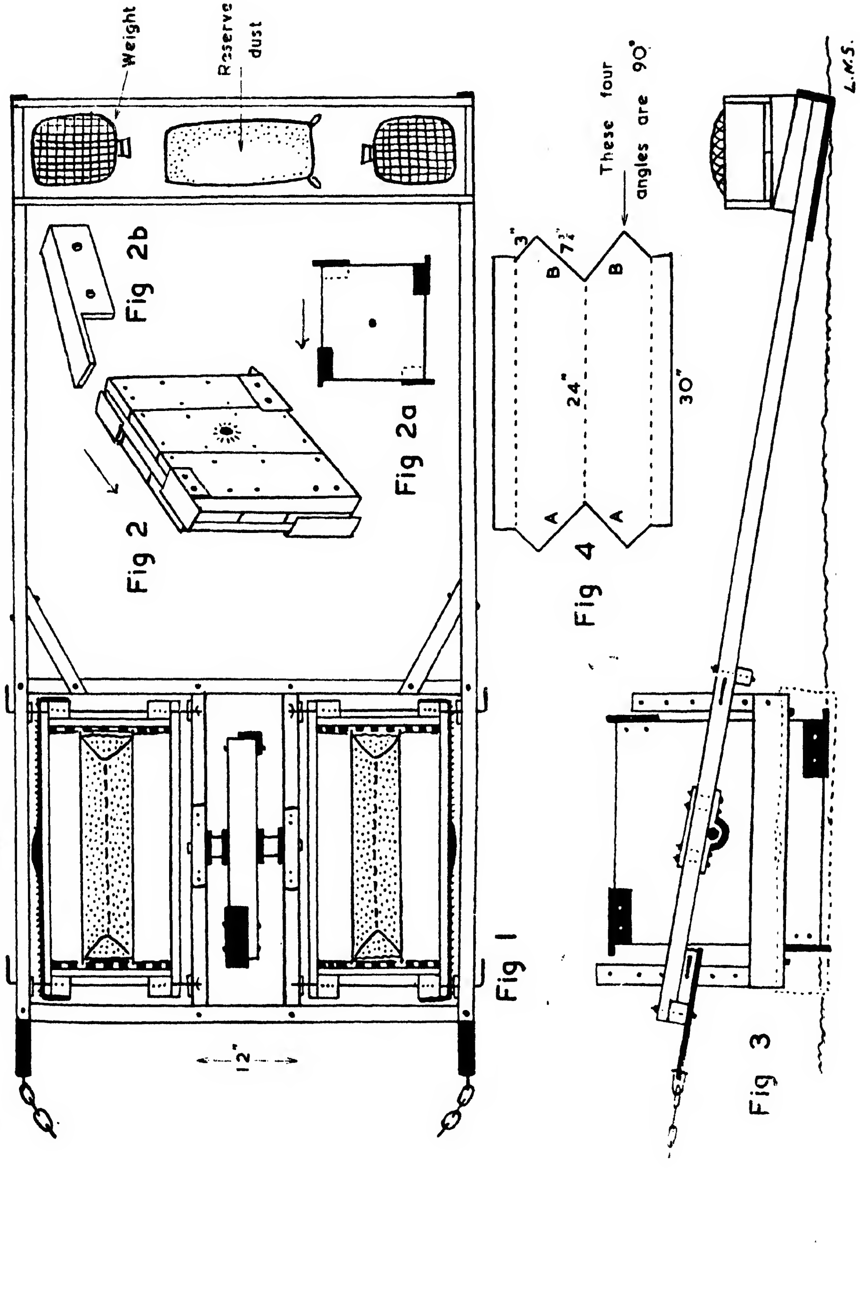
The central partition of the framework to take the square wheel has an internal width of 8 inches. The square wheel is constructed on the same lines as described in the previous article ; there are, however, three thicknesses of wood to give extra strength and stability (Plate 1, Fig. 2). The wheel is made from three layers of wood, each layer consisting of three planks, the central layer running at right angles to the outer layers. The dimensions of each plank are 24 inches × 8 inches × 1 inch. These planks are bolted together as indicated and provided with four turning lugs made from pieces of angle-iron (Figs. 2, 2a and 2b). Each lug in turn digs into the soil, causing the wheel to turn. If angle-iron cannot be obtained as wide as 3 inches, it is advisable to put the pieces on alternate sides of the wheel, so that the wheel sits easily in a vertical position. The projection of each lug beyond the wheel is 1 inch. Fig. 2b shows the portion of a piece of angle-iron which has to be cut out in order to make a turning lug ; two lugs will be mirror-images of the other two. Fig. 2a shows clearly the lugs on alternate sides of the wheel ; arrows indicate the direction of travel of the wheel.

The Wheel The wheel is mounted in the frame in the same way as the wheel of a wheelbarrow, i.e., the wheel rotates on a fixed axle. The axle is held firmly by means of a bracket beneath each wheel, and a plate in the top side of each member prevents the bolts from sinking into the wood. (If an additional strip of metal is run the whole length of the underside of the wheel members in addition to the brackets, an exceptionally strong job results.) Distance pieces of metal tubing and washers keep the wheel centrally on its axle. Plate 2, Fig. 4 shows the mounting of the wheel as seen in section.

The construction of the metal bearing in the centre of the wheel is by a simple method which does not involve any thread-cutting or help from a skilled mechanic. A hole is bored through the wood so as just to take a length of steel tubing about 5 inches long and having an internal bore of not more than $\frac{1}{16}$ inch greater than the diameter of the axle; a suitable diameter for the axle is about 1 inch. A length of tubing of about 1 inch will protrude on either side of the wheel, and four vertical cuts are then made down the tubing with a hack-saw to the level of the wheel as shown in Fig. 4a. The cut sections of the pipe are then hammered down flat and into the wood in the form of an eight-pointed star, as shown in Fig. 4b. The bearing should be well greased before assembling the wheel.

The machine is pulled by chains attached to two drilled strips of iron bolted into the front of the side members, as shown in Plate 1, Figs. 1 and 3.

PLATE I


Weight
Reserve dust
Fig 2b
Fig 2a
Fig 2
3"
7½"
B
A
24"
30"
These four angles are 90°
Fig 4
L.M.S.
3' 4"
12"
Fig 1
Fig 3

Blocks of wood fill in the spaces between the iron bars and the side members for additional strength. Front adjusting rods for the trays, to be described later, run through holes in these blocks.

Dust Trays and Hoppers The next task is the making of dust trays and dust hoppers. The construction of a dust tray is shown in Plate 2, Fig. 1. It will be seen that it is an open-bottomed tray with four uprights, the two front uprights being longer than those in the rear. The ends of the trays bear a series of wooden fillets so that the dust hoppers can be varied in position to suit different row widths ; the effective width of the dust hoppers can also be adjusted in the same way. A narrow strip of wood is fastened below the fillets to prevent the hoppers dropping down too far.

The dust hoppers are cut from hessian according to the plan shown in Plate 1, Fig. 4, and correct measurements, where a 2-foot wheel is used, are given. All that is required is to sew edge A to edge A, and B to B. The sides are then lapped over two plywood partitions and nailed on with battens. Plate 2, Fig. 1a shows a hopper made up and ready to be fixed to the partitions. Fig. 1b shows the hopper attached to partitions and ready to go with the dust tray. A pair of hoppers should be made of each of the three grades of hessian.

The dust trays can be raised or lowered so that the bottom of the dust hoppers is just over the plants on flat land or on ridges (Plate 2, Fig. 3). The trays are adjusted by means of iron rods passing through holes in the uprights of the trays and through holes in metal plates ; the trays should be parallel to the ground. The metal plates are bolted on to the side members of the frame and the members which carry the square wheel (see Plate 2, Fig. 2 ; also Plate 1, Figs. 1 and 2). A light wood lid should be made to cover the top of each dust tray to prevent dust from blowing about.

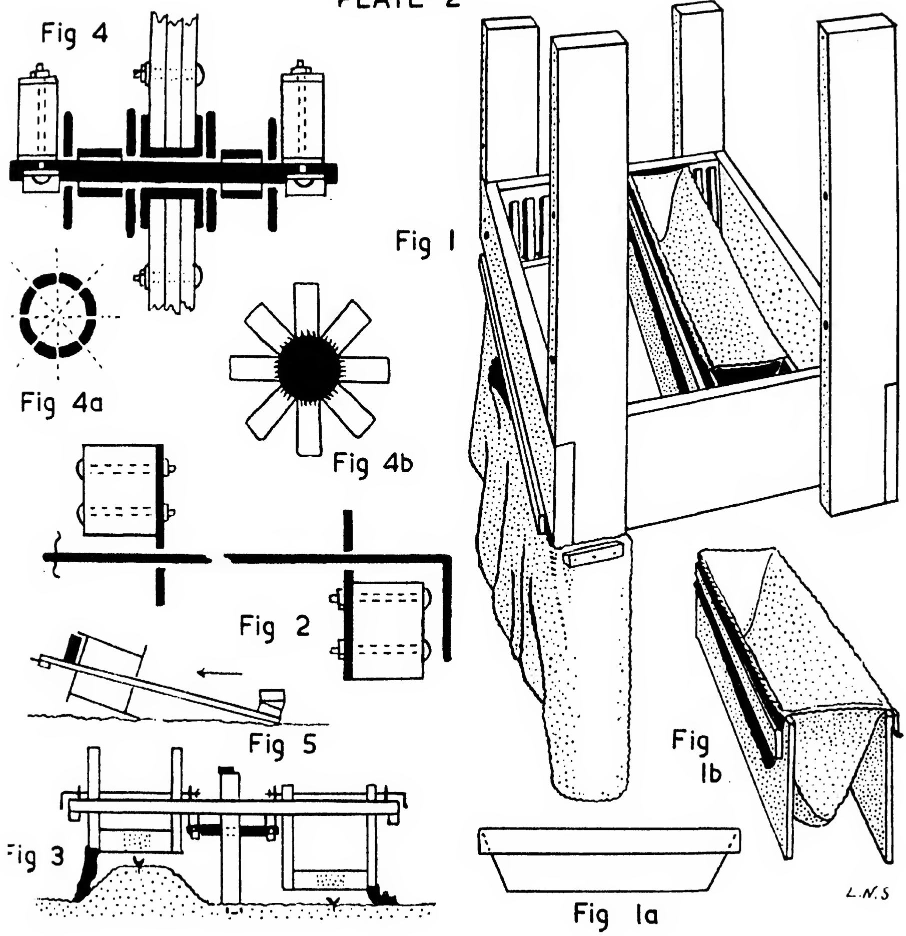
Hessian Windscreens The final task is the provision of hessian windscreens on the outsides of the machine. These windscreens are attached to the dust trays as shown in Plate 2, Fig. 1. Each windscreen consists of a bag made of double hessian, so as to form a pocket into which soil, or a few stones, may be dropped through an opening.

The screens are made so that they just touch the soil when the trays are in their highest positions. When the trays are lowered the screens drag on the ground. The square wheel acts as a centre screen. With these screens it has been found possible to dust satisfactorily in a fair breeze without appreciable drift, and so greatly increase the number of possible dusting days. The positions and action of the screens are indicated also in Plate 1, Figs. 1 and 2 and in Plate 2, Fig. 3.

A simple device for promoting easy turning of the machine at the headlands is shown on Plate 2, Fig. 5, a sideview diagram. A block of wood wide enough to lie across both wheel members is slipped in before turning, so that it lies under the top turning lug. This keeps the bottom lug off the ground and the machine then skids round easily on the rear, backwardly directed, lug and the rear end of the side members.

The Machine in Operation The quantity of dust that can be applied per acre depends on the grade of hessian used for the hoppers, the width to which the hopper is adjusted, the speed of travel of the machine, and the hardness of the ground. By taking these points into account, it is in practice very easy to apply a dust to give just the degree of cover desired. As a rough guide it may be stated that the fine

PLATE 2



hessian gives light dressings of the order of 25 lb. per acre, the medium hessian 50 lb., and the coarse material heavy dressings. These remarks apply when the machine is horse-drawn, and, in general, it is the medium hessian that will be used most frequently. The greater speed obtained with a tractor can result in fine hessian giving dressings equivalent to horse work with medium hessian. For hard ground, finer hessians should be used. The appropriate hessian can easily be chosen by trial, and the speed adjusted until the cover desired is obtained.

HITCHING HORSES

H. J. Hine, B.Sc. (Oxon)
Ministry of Agriculture and Fisheries

THERE are still occasions when horses are more economical than tractors for cultivations and cartage, and there are few farms where a team of horses cannot usefully be employed in addition to the tractor. Skill in tending horses and in getting the best work out of them is becoming rarer, and therefore it is thought that some notes on hitching and on harness and traces may not be out of place.

When horses are being used singly, or in teams abreast, simple harness, without breeching and saddle, can be used when they are pulling implements that have no shafts. A direct pull is all that is needed, and this is taken straight from the collar. The draught or trace chains are hooked through a short tug chain to the U-shaped hame, which fits into a groove round the collar. A simple cross-strap to guide the chain and the rope reins, and a bridle with a bit and blinkers, complete each horse's equipment. Where a pair of horses is being used the bits are inter-connected by light chains. The pull of the two horses is linked through a whippletree.

Effective Pull If horses are incorrectly hitched to the wagon or implement, their pull will not be fully effective, and they will tire easily. For instance, when two horses are linked in line, if the chain from the leading horse is connected directly with the collar of the rear horse, one component of the pull by the leading horse presses down on the collar of the rear animal. This downward thrust tires a horse very quickly. It is better for the rear horse to be harnessed with a cart saddle having a ridge for a cross-chain, and the chains from the front horse should be connected by a second chain to the hame of the rear horse. In making the connections the aim should be to have all the chains pulling in line as nearly as possible (see Fig. 1).

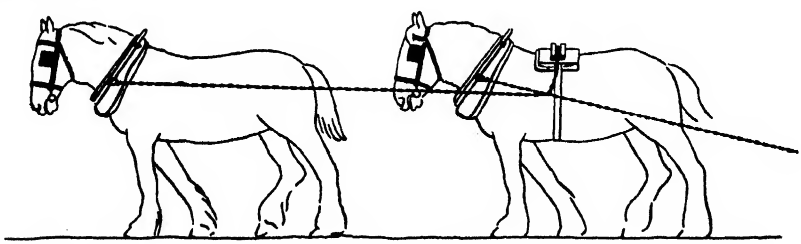


FIG. (1) SADDLE ON REAR HORSE WHERE TWO HORSES ARE LINKED IN LINE

Side draught wastes energy and is uncomfortable for the horses. If three horses abreast have to be used to draw a pole implement, it is difficult to eliminate side draught completely, but it can be reduced by making the chains as long as possible. If, however, the three horses are going to be used regularly with pole implements, it is well worth while to use a bogy carriage, since it saves also the downward thrust on collars. It is particularly useful on a binder, for it also helps sharp turning.

When two horses of different pulling powers are teamed abreast, one of the clevises of the whippletrees should be moved along so as to make the two arms unequal in length. The length of the arms of the whippletree should be in inverse ratio to the pulling power of the horses. The pull of the horses can be taken to be proportional to their weight. For example,

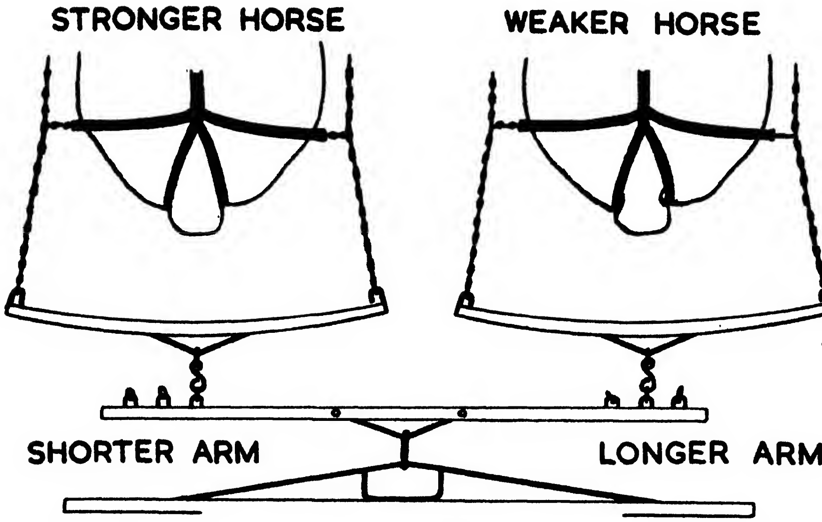


FIG. (2)
HORSES OF UNEQUAL POWER TEAMED ABREAST

suppose one horse weighs half as much again as the other. Then the whippletree's arm ought to be pivoted at a point two-fifths of the way along its length. The weaker horse should have the longer length of the whippletree arm (see Fig. 2).

When the type of implement allows them, shafts are better than a pole, for shaft harness can be arranged to give far less weight on the neck than can pole harness.

Collars and Saddles Collars ought not to fit tightly at the top. It should be possible to see daylight between the neck of the horse and the peak of the collar. The rest of the collar should fit closely enough to prevent it rocking, but the padding should be sufficiently pliable to let it lie evenly on the shoulder, without uncomfortable pressure anywhere.

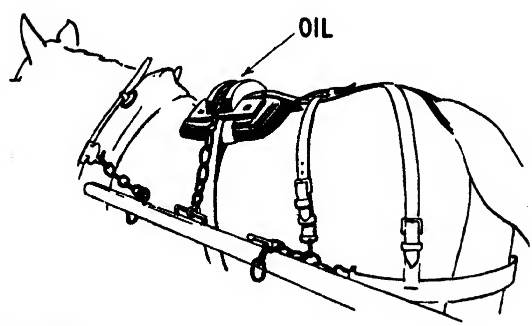


FIG. (3)

LUBRICATION OF CHAIN IN GROOVE OF SADDLE

Good clean pad covering over good quality stuffing or pneumatic or sponge rubber filling facilitates this even fit and may prevent sores forming.

Good padding is equally important for saddles. The cart saddle must not touch the backbone. The weight should be carried over as great an area of the horse's back as possible.

The ridge chain of the saddle should be kept oiled, so that it will slide smoothly in its groove. If it is rusty and binds against the sides of the groove the saddle will tend to move with the chain and so chafe the horse's back (see Fig. 3).

FLUORESCENT LIGHTING FOR POT CULTURE

AN AID TO WINTER RESEARCH

A. J. Low, M.Sc., M.Sc.Agric., A.R.I.C.
Jealott's Hill Research Station, Bracknell, Berks

IN agricultural research it would bea great help if crops could be grown in winter as well as in summer. The limiting factors in winter are, of course, temperature and light. Temperature can be controlled by using heated greenhouses but light is more difficult. The aim of this article is to describe a system of lighting which gives good vegetative growth during the winter.

Attempts in the past to use ordinary incandescent electric lighting have not been wholly successful. When sufficient light is provided by unprotected incandescent lamps the heat emitted makes the normal growth of plants impossible. To overcome this difficulty, cumbersome screens have to be used to cut out the heat rays. The heat emission from fluorescent lamps, however, is very low, and in our tests batteries of tubular fluorescent lamps have proved very successful.

In preliminary trials a number of fluorescent lamps differing from one another in the composition of the light they emitted were compared with the standard "daylight" lamps. The standard "daylight" lamp was found to be the most satisfactory.

To keep the cost as low as possible artificial lighting has been used to supplement daylight and not as the sole source of illumination. The duration of the winter daylight was extended and its intensity increased, except between 10 a.m. and 2 p.m., apart from very dull days, when the lamps were run during this period also.

Extended "Daylight" The average *maximum* intensity of daylight (direct sunlight excluded) in December is about 700 lumens per sq. foot with 300 at 9 a.m. and 3 p.m. (G.M.T.). In June the maximum is about 3,000 with 300 at 4.30 a.m. and 7.30 p.m. Examination of the literature indicated that reasonable growth of oats, rye, mustard, clover, etc., could be expected with a light intensity of about 400 lumens per sq. foot, and an arrangement of fluorescent lamps was devised to give this intensity at crop level. As shown below, this gave satisfactory growth. To use much higher intensities would not only increase the cost, but the

necessary increase in the number of lamps to give high intensities would in the "off" periods exclude a great deal of daylight or call for an elaborate mechanism for moving the lamps when not in use.

The length of "day" in winter was extended to 16 hours. The lights were on from 4 a.m. till 10 a.m. and from 2 p.m. till 8 p.m., being automatically switched on and off with a time-switch. This meant that at 9 a.m. and 3 p.m. in December illumination approached 700 lumens per sq. foot.

The small array of lamps used in the 1946-47 winter is shown in Fig. 2. It consisted of fifteen 80-watt daylight fluorescent lamps fixed on a metal framework. The lamps were set 4 inches between their centres. The larger arrangement used in 1947-48 is shown in Fig. 1. The framework carrying the fluorescent lamps was hung on chains, so that the height could be adjusted as the crops grew. The lamps were arranged to give a distance of 6 inches between their centres and 24 inches above the top of the crop to give at crop level a light intensity of 400 lumens per sq. foot at 4 a.m. and 8 p.m.

The electric current cost one penny per kilowatt/hour, so that the cost of the supplementary lighting (excluding capital outlay) was about one half-penny per sq. yard, per hour.

Vegetative growth of oats, Italian ryegrass, mustard and clover appeared normal, and the rate of growth and the bulk produced was as great as in mid-summer. The greenhouse was maintained at 50-60°F. Figs. 3 and 4 show pots of mustard and Italian ryegrass grown in winter with and without supplementary lighting. During summer the average weight of oven-dry grass per pot is between 4.5 and 5.0 grm. ; the average weights obtained for the same length of time in winter were 4.6 grm. from the pots receiving supplementary light, and 0.8 grm. from those receiving winter daylight only.

So far only mustard has been carried through to maturity, and this flowered normally. The other crops, all of which have been grown for experimental purposes, have been harvested whilst still in the vegetative phase.

Whether the crops grown are normal in all respects is not known. In particular, the length of "day" arbitrarily fixed at 16 hours in the trials reported is obviously important in getting normal growth of "short" and "long" day plants. Vegetative growth was, however, very good with all the species used (oats, Italian ryegrass, white mustard and white clover). Chemical analysis of the Italian ryegrass showed that phosphorus, potassium and "true" and "crude" protein contents were all at the same level as in young grass grown out-of-doors in early summer.

The lighting shown in Fig. 2 has been used for replicated pot experiments. Evenness of illumination (the extreme sides being avoided) was shown by measurements of light intensity and by the fact that agreement between replicate pots was good. With Italian ryegrass the standard error per pot of the yield of dry matter was only slightly over 5 per cent. With this arrangement, 45 lamps effectively illuminated an area of 70 sq. feet and permitted satisfactory growth in 100 glazed pots 6 inches high and $5\frac{1}{8}$ inches internal diameter.

In the course of this work, advice and help of great value were given by Mr. W. F. Higgins, O.B.E., and Dr. J. W. T. Walsh of the National Physical Laboratory and the research staff of the British Thomson-Houston Company. All the equipment used in the early experiments was loaned by the latter firm.

See illustrations on p. iv of art inset.

BRITAIN'S NORTH AMERICAN TREES

J. D. U. Ward
Abingdon, Berkshire

THE two tallest trees in the United Kingdom are both Douglas firs, about 180 feet high, yet less than 110 years old. The tallest tree in Ireland is a Sitka spruce, a species described by a Forestry Commission spokesman as "unquestionably the most important and valuable of all additions to our stock of forest trees". Both Douglas and Sitka are North American trees, and so are all three species of which an eminent "private enterprise" forester recently noted:

> We have young stands of American silver fir and western hemlock in Scotland, far heavier for their age than any other stands of trees we have previously grown; we have at Leighton in Montgomery a stand of Redwood which is probably the heaviest stand of any trees in the country, yet it is well under 100 years of age.

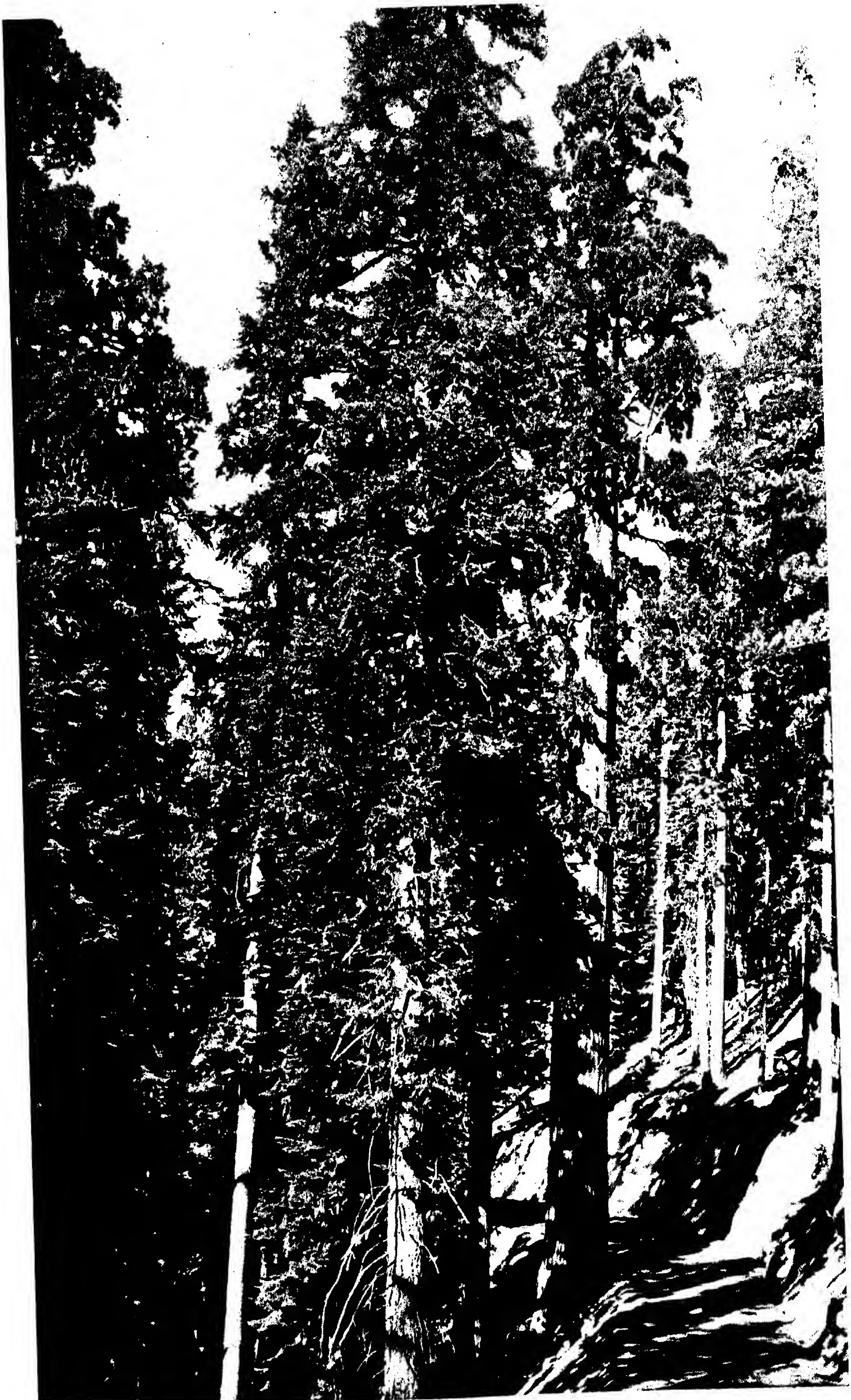
Other North American trees now planted in British forests for timber production include the important Western red cedar, and several secondary yet really useful species such as Lawson's cypress, the noble silver fir, the Monterey, Lodgepole and Bull pines, and the Wellingtonia. Familiar garden and park trees from America include such species as the Monterey cypress or *macrocarpa*, the swamp or bald cypress, the incense cedar, the tulip tree, and the blue spruces.

Making up Nature's Deficiencies It is an imposing list, and since some people fear that Britain's forests may soon be wholly dominated by foreign trees, and especially by American trees, two questions may well be asked: Why have American trees been introduced in such large numbers; and why are they considered so important?

First, we must remember that nature has not distributed her plant gifts very evenly; there are curious inequalities. For example, Dr. E. Pfeiffer notes in his recent book, *The Earth's Face*, that there were thousands of different plant species in some areas (such as Asia Minor) against mere hundreds in others (such as temperate Northern Europe.) Secondly, there have been "accidents". We know from the evidence of fossils that, thousands of years before the Ice Age, Britain had a rich and varied list of trees, which included such species as the swamp cypress and the Wellingtonia—both now regarded as aliens since they have been reintroduced from America. When the ice receded some plants recolonized our country, but before the process had gone far, before even the Norway spruce of Europe was re-established, Britain became an island. We were left with a pitifully poor list of trees: oak, beech and ash were the only hardwoods or broad-leaved trees of first importance; and of conifer or softwood trees, there was only one of general utility—the Scots pine. It is, then, because nature has given us so few trees that we have had to adopt so many from abroad.

The success of certain American trees in this country (where they prosper much better than in Central Europe) may be due largely to our maritime climate, whose mildness and moisture compare well with the climate of parts of America's Pacific coast. This point deserves to be stressed. Some trees (for example, Sitka spruce) do best with us when grown from seed collected on islands with a climate as much like ours as possible; and to grow the best Douglas firs we need seed from the fairly low coastal regions of British Columbia rather than from higher elevations inland.

In other respects also the provision of forest tree seeds is of great importance. If a farmer makes a mistake only one year's harvest suffers; but a forester's mistake may prejudice from 50 to 250 years' harvest. There



Sequoia trees along Generals Highway, Sequoia National Park, California (note the relative size of car).

PORTABLE POULTRY HOUSES (see pp. 214-215)

ON WHEELS

ON SKIDS

General view of "car chassis" type. Note position of broody coop.

"Lincolnshire" house on skids.

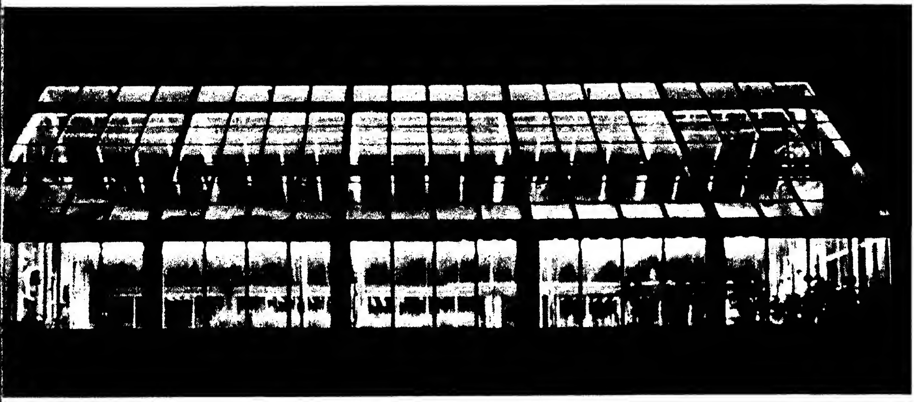


Fig. 1 Photograph taken at night of arrangement of fluorescent lamps in use during 1947-48 winter.

Fig. 2 Arrangement of fluorescent tubes over a group of pots.

Fig. 3. Mustard
5 weeks after germination: (*left*) Daylight only; (*right*) Daylight plus fluorescent light supplement.

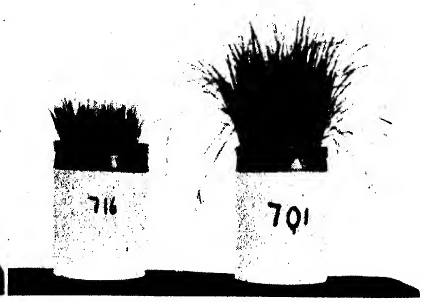


Fig. 4. Italian Ryegrass
10 days after cutting hard, ½-inch above edge of pot: (*left*) Daylight only; (*right*) Daylight plus fluorescent light supplement.

have been some disastrous errors in the past, both in Europe and in America. For example, even different species have been confused, and seed of the Eastern hemlock (*Tsuga canadensis*) was sometimes, within the last fifty years, supplied as the seed of the Western hemlock (*Tsuga heterophylla*). Now, the eastern species is almost worthless as a timber tree, but the beautiful western species shows great promise. It should perhaps be added that the names of many American trees are confusing. These hemlock trees must not be confused with the poisonous water plants of the Old World. Again, *Thuya plicata*, the Western red cedar, from single trunks of which British Columbian Indians made canoes which would carry forty men, and which we now use to make cedar shingles and weatherboards, is not a true cedar at all. Nor, of course, is its relative in the Eastern U.S.A., *Thuya occidentalis*, which produces a timber light enough to make a one-man canoe weighing less than 11 lb.

American Importations over Four Hundred Years The history of how American trees came to Britain includes some interesting stories. *Thuya occidentalis* had been brought here as early as 1596, and some other species from the southern and eastern States (such as the swamp cypress, which is not a cypress, and the pencil cedar, which is not a cedar) were here by 1650. But the bulk of the western kinds now used so much in forestry came between 1820 and 1860. In 1825 David Douglas discovered in Oregon the sugar pine, the largest of all pines and the producer of the largest of all cones. There is a story that while Douglas was shooting some of the cones from a lofty tree, he was surrounded by Indians intent on scalping him; but he overawed them by drinking boiling water—or, to be precise, water to which effervescent salts had been added!

In 1833 Douglas introduced the Monterey pine, which is now grown not only in south-western England but also in South Africa, Australia and New Zealand, where it yields timber for making butter-boxes. The better known Monterey cypress (*Cupressus macrocarpa*) was apparently on the verge of extinction when it was found, and seed was brought to Britain in 1838. It comes from farther south than most of the important timber trees, and this southern origin doubtless explains its frost-tenderness. The first seeds of the great Wellingtonia (*Sequoia gigantea*, introduced into Britain in 1853) are said to have been collected by a Californian gold prospector, who sent them in a snuffbox across America by pony express, the postal charge being 25 dollars for less than 2 oz. Of the allied and already mentioned redwood (*Sequoia sempervirens*), H. L. Edlin says in his *British Woodland Trees* that a single stem may contain 30,000 cubic feet of timber—more than is usually found on 5 acres of a good coniferous plantation.

Our Future Timber As most of these forest species have been grown in this country for less than 125 years, and several are not mature until they are from 250 to 750 years old, it is impossible to be sure that their present high promise will be fulfilled. William Cobbett made great claims for the false acacia or locust tree (*Robinia pseudacacia*) from the Eastern U.S.A., and he foretold that it would take the place of oak because of its manifold superior qualities, but the species has done only moderately well in Britain—perhaps because of lack of sun. It is now planted in relatively small numbers, and more for amenity than for timber. Nevertheless, at the moment the timber trees of Western North America seem destined to occupy a prominent place in this country.

Further, people who advocate our growing fewer "aliens" and more native

oak and beech might remember first, that the land devoted to forestry in Britain is mostly poor and suitable only for growing conifers, and second, that the country's normal pre-war consumption of timber was divided between 6 per cent hardwoods and 94 per cent softwoods from coniferous trees !

Today's vastly greater demand for softwoods has one faintly ironic aspect. According to the old laws, as still enforced in some leases, the word "timber" as applied to trees meant only oak, ash and elm of twenty years' growth or more, with certain local additions such as beech in Buckinghamshire and birch in Yorkshire. None of the North American or other conifers which provide the great majority of our building timber today ranks as "timber" in the old sense. The change in meaning is a reflection of the change in building practice.

PORTABLE POULTRY HOUSES

I. W. Rhys, N.D.P.
National Agricultural Advisory Service, East Midland Province

It is generally agreed that expansion of egg production in the near future will have to take place mainly on the general farm. It is also recognized that farm flocks are probably best housed in portable units Benefit is derived from the birds manuring the land evenly and aerating the turf by scratching. The houses most generally used are either folds or slatted floor units.

East Midlands Type In exposed situations in the East Midlands farmers have not been entirely satisfied with either of these types. As a result a house has been evolved that is, so far as I am aware, peculiar to this district. It has a solid floor giving a protected scratching space of 14 feet × 7 feet, and houses 40 to 50 birds.

This house is seen in two main forms, one mounted on an old car chassis, and the other on skids. Both have their champions and, as with other features of animal husbandry, their relative merits are argued interminably. Whether on wheels or skids, the house is moved by horses or tractor, at discretionary intervals ; the latter depends upon the state of the weather, the nature of the soil, and the condition of the land around the house.

Of the external appearance, there is little that needs special comment. There are hinged lights above the nests, and floor lights below. Each house has its own broody coop fixed high on the wall, out of reach of foxes.

It is inside that the house has unorthodox features. There is no droppings board, the birds roost on a slatted floor with slats covering an area about equal to the usual droppings board, and below is a sloping ramp faced with a metal sheet. This "hopper" runs from the front of the roosting slats to the angle made by the floor and the back wall of the house, and here the droppings accumulate until cleaning out is needed. Contrary to expectations, this is not very often. In fact the whole arrangement can be described as a house fitted with a droppings pit ; but the pit is of a shape that makes cleaning

easier and does not restrict the floor space available for indoor scratching when bad weather keeps the stock indoors.

When cleaning out is needed, and this is usually done just before the house is moved to a new site, the attendant lifts hinged sections in the rear wall that give access to the pit and spreads the accumulated droppings directly on to the land. This is not a long job and, as the houses usually pass over the land once only before it is ploughed and cropped, there is little chance of the usual troubles that arise where birds have constant access to their droppings.

The nests, fitted just below the movable lights in the front wall of the house, are normal in design. At the same level, but at the door end, there is also a double hopper in which mash and grain can be stored. Buckets are filled by lifting a slide at the bottom of each compartment. Dry mash feeding is generally practised on the East Midland farms, for it calls for less labour.

Drinking water is supplied in a trough refilled from a barrel that catches rainwater from the roof. This is found to be adequate for the greater part of the year, though in dry spells the water-cart has to be used. To prevent fouling of the supply, the mouth of this barrel is covered with a sack which is held in place by half bricks tied in each corner.

Litter from the floor is spread behind the house just before the move to a new site, so saving the labour of carting it elsewhere for spreading. With the type of house mounted on a car chassis, the constant flow of air under the floor keeps it very dry, so that frequent renewal of litter is unnecessary.

Here then is a house that combines the mobility of the slatted floor unit with the added protection of the semi-intensive system. It is a design that is rapidly becoming popular.

It is not easy to compare labour costs, but an example of labour-saving on a holding on light land in mid-Lindsey may be cited. On this farm additional help was given with moving (but not with cleaning), water was brought to the site when necessary and food was delivered to the house. With these exceptions, one man was able to do all the routine work involved in the management of 5,000 birds.

See illustrations on pp. ii and iii of art inset.

The Jones-Bateman Cup for Research in Fruit Growing

The Jones-Bateman Cup, presented by Miss L. Jones-Bateman, of Cae Glas, Abergele, in 1920, for the encouragement of fruit production is offered for award triennially for original research in fruit culture which has added to our knowledge of cultivation, genetics, or other relative matters. The Cup is offered for award in 1948.

Candidates should submit accounts of their work by October 31. The work dealt with should have been mainly carried out by the candidate in the United Kingdom and mostly during the last five years. The Cup will be held for three years by the successful candidate, who must give a bond for its safe return. The holder will be able to compete again on the next or any succeeding occasion. When the Cup is relinquished the holder will receive a Hogg Medal which will be specially struck in gold if conditions allow it, otherwise a token gold medal will be substituted.

POULTRY BREEDING AT REASEHEATH

A TEN YEARS' SURVEY

W. B. MERCER, R. E. LOUCH and J. A. GREEN

The major portion of this article was written last year before staff changes at Reaseheath. Mr. Mercer is now Provincial Director, National Agricultural Advisory Services, West Midlands, and Mr. Green is engaged in commercial poultry farming.

AN account of the Reaseheath poultry flock was published in this JOURNAL shortly before the war.* It may be recalled that the flock then comprised about 120 Rhode Island Red layers and a similar number of Brown Leghorns. Established in 1920, the flock had run successfully for a number of years, but in common with most flocks in the country, had suffered from high mortality in the early 'thirties. A drastic overhaul of methods had then been made.

For the past twelve years the following principles of management have been followed consistently: rotation of poultry and arable crops; maintenance of flock by females bred from mature birds only; use of progeny-tested males; and open-air rearing.

The overall effect of these measures has been striking. Health has improved, mortality rates have fallen markedly, and productive capacity has been maintained at a reasonably high level. As an illustration, the pullet year records for the period 1935-45 may be cited (72 birds of each breed till 1939, thereafter 48 of each breed).

Production and Mortality of Pullets Bred from Hens

Year Hatched	RHODE ISLAND REDS		BROWN LEGHORNS	
	Average production three winter months	Mortality twelve months Oct-Sept	Average production three winter months	Mortality twelve months Oct-Sept
		per cent		*per cent*
1935	29.7	44.1	31.5	23.1
1936	33.3	32.0	33.3	14.5
1937	40.5	14.0	28.5	11.1
1938	51.5	13.8	31.2	4.16
1939	49.0	9.7	33.0	8.3
1940	47.0	4.2	28.4	12.7
1941	34.8	4.2	31.8	2.1
1942	24.8	—	22.1	4.2
1943	24.6	6.2	27.2	2.1
1944	37.7	2.1	35.5	4.2
1945	36.0	4.1	34	2.2

In examining the figures one must, of course, allow for the great change in the plane of nutrition since 1939. Before the war all classes of stock were fed liberally on first-class rations compounded on accepted scientific principles. During and since the war they have been fed on what we could get. Our main concern has been to "give 'em summat to fill their craws". Apart from such meagre rations as could be allowed, they have had to subsist on potatoes, blitzed grain, and oat husk meal—with the emphasis on husk and decoctions of garbage, known locally as "puddings," of uninviting appearance and varying content. On feed of this kind growth-rates have slowed down and pullets have reached sexual maturity at least a month later than

* *Agriculture* (1939) **46**, 6.

in pre-war years. It is impossible to compare egg yields obtained on such different standards of feeding. To some extent no doubt the same limitation attaches to any other comparisons that may be made between results obtained in the two periods.

Rotation of Poultry and Arable Crops Two small paddocks have been used for rearing. In a larger field adjoining, breeding houses disposed down a centre line have allowed runs to be erected on either side alternately. The land has throughout been worked on a short rotation, at present :

First year	Poultry
Second ,, ...	Poultry
Third ,, ...	Kale or potatoes
Fourth ,, ...	Silage crop seeded down.

This rotation has at least the merit of simplicity. Silage is an excellent crop in which to seed down, since it is off the ground by July. Kale and potatoes both do well on ploughed-out turf. Theoretically the rotation provides for the land being clear of poultry for two complete years in every four. Actually we found that that period tends to get whittled down at both ends to little more than sixteen or eighteen months. Even so it appears to effect its main purpose. There has been extremely little trouble from worms or infectious diseases.

Rearing A good many of the chickens hatched are always sold. Since sales are made indiscriminately from different hatches and at varying ages, it is impossible to calculate a true rearing mortality rate. For *comparative* purposes, however, the overall figures for yearly losses during the rearing period constitute at least a reliable indication of the trend of events.* Again, however, it is desirable to divide the history into two periods, since sales of day-old and very young chickens increased greatly during the war.

The vital statistics for the past thirteen years have been :

	Hatched No.	Died percentage of hatched	Notes
1935	4,391	31	Reared intensively
1936	3,936	20	Reared outdoors on old grass.
1937-39 (av.)	4,981	8	Reared outdoors on new seeds
1940-43 (av.)	7,305	4	Reared outdoors on new seeds
1944-46 (av.)	11,309	4	Reared outdoors on new seeds

Breeding Like other breeders of farm stock, the poultry breeder works within a field whose boundaries are set by popular taste. Most of his birds are bred for sale to other people, and he must therefore aim at producing something that other people will consider good. In some respects he is very fortunately placed ; poultry develop rapidly—they have a high reproduction rate. If most of the birds will live two years the annual replacement rate need not greatly exceed 0.5 per bird ; the females will yield fifteen or sixteen pullets during a breeding season. In practice, it is generally found convenient to limit the period during which hatching eggs

* Judging by losses in the small number of pedigree stock hatches which have been reared annually, the true mortality rate between hatching and sexual maturity would appear to average about 15 per cent.

for stock replacement are kept to a few weeks. Even so, sufficient birds can easily be reared to allow liberal scope for selection.

Sires too can be purchased in relatively cheap form as eggs and tested even while the females are growing to maturity.

Moreover it is comparatively easy to apply numerical standards of judgment to many life factors for which no parallel exists in the mammals. Thus, if a foundation stock is maintained by breeding from two-year-old birds, and males are bought as eggs, one can readily assemble at least the following information at the time the breeding pens are made up :

	Males mated to	**Hen-bred Pullets**
EGGS	(purchased)	Factors known when selecting
	Fertility of clutch	**Hen's Performance**
	Hatchability of clutch	(a) Winter or year's egg yield
CHICKS	Rearability percentage	(b) Fertility percentage
	Growth and colour of chicks	(c) Hatchability ,,
COCKERELS	Selected on type and handling	(d) Rearability ,,

After one year's test breeding the following facts are known :

Cockerels' Performance	**Pullets' Performance**
Their livability	Their winter yield
,, fertility	,, annual yield
,, hatchability	,, family mortality
Rearability of chicks	,, egg size
Daughters' winter egg yield	,, fertility
,, ,, mortality	,, hatchability
	Rearability of chicks

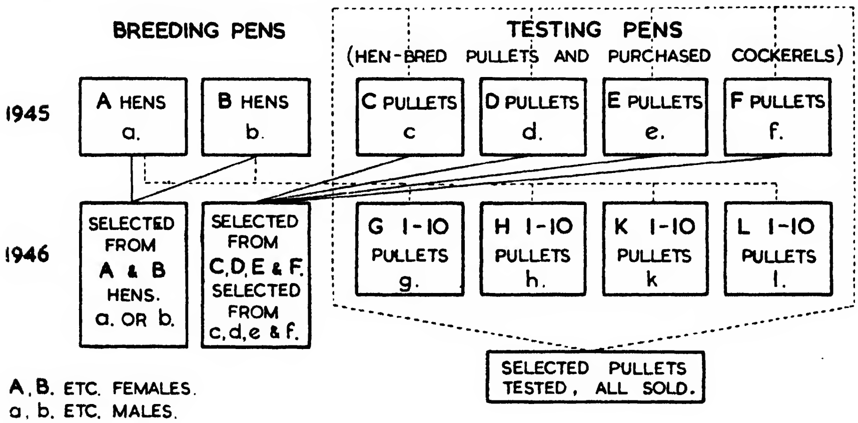
From these records the best males (now second-year cocks) are chosen to head the breeding pens. The best yearling hens are grouped together to maintain breeding stock and replace old hens.

Surely if figures are any guide in breeding, the poultry breeder's path is plainly pointed. In truth the figures are not quite as useful as they appear at first glance. Their abundance is embarrassing ; so too is their nature, for fowls, like human beings, display their characters in shades of grey rather than in sharply defined blacks and whites. Few families or even individuals are outstandingly good in respect of all characters measured.

We have for many years adhered to a system of progeny testing of males, purchasing eggs from recorded flocks, hatching them and mating the cockerels to groups of pullets selected from the progenies of foundation hens, and retaining a selection of their daughters. Trap-nesting has been limited, as a rule, to three winter months only. While admitting this weakness in the system, it is some comfort to reflect that even full records would have been of small value, war-time feeding being what it was. In making the decision to restrict trapping, however, we were influenced not only by labour considerations ; we had to decide which breeding factors were of greatest importance and which of least consequence. Livability and apparent vigour were placed first amongst the desirable characters, and we have throughout used livability—as demonstrated by the individual and family record—as the primary deciding factor in selection.

The system has, of course, involved the maintenance of foundation stock by mating males over two years to females of similar maturity. At the outset we contemplated using only two-year-old birds of either sex ; but as experience has accumulated we have found it practicable to retain some males for at least three seasons, and regularly to include in the breeding pens a proportion of females three and four years old.

The set up of the breeding system has therefore gradually become :



Effective Life of Males We were troubled at the outset by fears that two-year-old males—especially when mated to hens—might prove poor "getters". In fact we have rarely been disappointed by a two-year-old bird ; we have used nine for three years and one for four. A summary of age effects is as follows :

	Fertility *per cent*	Hatchability *per cent*	Rearability *per cent*
First Year	51 R.I.R. s 90.5 (4,557 eggs)	67.4	90.6
	52 Brn. Leghorns 90.4 (4,644 eggs)	73.7	81.8
Second Year	21 R.I.R. s 89.6 (2,471 eggs)	81.9	84.3
	18 Brn. Ls. 83.2 (2,346 eggs)	72.8	85
Third Year	6 R.I.R. s 85.5 (706 eggs)	80.4	86.8
	3 Brn. Ls. 74.3 (339 eggs)	74.8	85.5
Fourth Year	1 Brn. Ls. 64.5 (124 eggs)	60.0	81.2

Deaths among Males The death-rate among males has, however, been high throughout, and a good many have been rejected during their first year owing to low fertility and hatchability. The following table summarizes results of the test years :

	Tested	Died	Discarded	Retained
R.I.R.s	51	14	14	23
B.L.s	53	11	20	22

Amongst the discarded are included a number of birds not noticeably defective but merely surplus to requirements.

Two-year and older birds used during the period under review (naturally the majority are those figuring in the "retained" group above) have given the following results while in the breeding pens :

	Used	Died	Retained
R.I.R.s	29	6	6
B.L.s	22	2	5

Elimination of Hereditary Defects From time to time defects apparently attributable to the male have appeared in the progeny during the test year.

In 1945 an apparently good cockerel produced a daughter which died from lymphomatosis.

In 1937 a cockerel after test went blind. Several of his daughters went blind during the following winter.

In the same year pullets by another male showed a marked tendency to lay small eggs.

In all cases the males and their families were discarded.

With males we are dealing with averages relatively few in number. With females we have to handle ten or twelve times the number of individual records.

Effective Life of Females The risks in retaining old females as breeding stock are not nearly so great as with males. We have therefore retained all hens as long as they appeared capable of continued breeding, provided they still seemed sound in wind and limb.

The following table summarizes the results of this practice :

Breed	Total birds	No. of years bred from 2.	3.	4.	5.	6.
R.I.R.	106	53	41	10	1	1
B.L.	110	51	43	13	2	1

Thus approximately half the birds used in the breeding pens were fit for continued breeding in their third year of life ; and more than one-third, in either breed, survived to breed again in their fourth year.

As evidence of the standards maintained by such practice, the following data from the records of the 1946 season may be cited :

Breed	Pen	Age of Birds	No	Av. Winter Yield	Av. An. Yield	1945 Breeding Record Set	Hatched	Reared
		years						
B.L.	A.	5	2	42	—	27	21	18
		4	3	39	—	44	36	26
		3	7	46	—	95	76	59
	B.	2	14	32	199	108	90	64
R.I.R.	C.	4	3	36	—	68	62	46
		3	8	47	—	152	133	95
	D.	2	12	46	200	111	99	83

It will, we think, be agreed that the results represent good progress. At the outset our original intention was to reduce mortality, and this has been achieved in Rhode Island Red hen-bred pullets with a mortality range between 0 and 4 per cent during the past six years, except for a slight rise to 6 per cent in 1943. With Brown Leghorns, mortality rates are equally good—an annual loss of between 2 and 4 per cent for the past five seasons.

In each breed we are turning out a steady stream of birds with a good average egg output and expectation of life.

High regard is paid each year to fertility and hatchability performance when the sires and dams are selected for future breeding, and it may well be that these factors are now strongly impressed in the stock, for both characters were markedly good throughout the past season, despite the very adverse weather in the breeding months.

As yet no striking line has appeared amongst the hundred males tested ; no happy "click" of dominant genes has occurred. What more then ? At present it looks like keeping on keeping on, buying each year the eggs to produce our unknown sires, scrapping those that fail on test and using the remainder, or closing the flock and launching out on the path of line breeding, treading, like Agag, delicately.

FARMING AFFAIRS

The Cropping Programme for 1949 Many farmers will already have seen the figures for the 1949 Cropping Programme published in the press; and one of the tasks of the County Agricultural Executive Committees and their District Committees will be to ensure, as soon as possible, that every farmer knows the share of the acreage of the various crops which he is expected to grow on his land. The crops for which targets have been set are wheat, potatoes, and sugar beet; there is a target for the total tillage area, and the acreage of linseed is to be substantially increased.

The WHEAT target for the United Kingdom is 2½ million acres, most of which has to be grown in England and Wales because the climate in Scotland and Northern Ireland is not so suitable for this crop. In total, the wheat target is not very different from that for 1948; but the changes in some individual counties are considerable. Thus those counties in which wheat is not a suitable crop for maximum food output have had their targets reduced; but the loss has had to be made up elsewhere. For example, counties like Lancashire and Cheshire are carrying a very high number of dairy cattle, and it is believed that reductions in the area of wheat will help farmers to maintain the acreage of forage crops so that milk yields can be kept up. Most of the compensating increases are being borne by the traditional wheat-growing counties in the East such as Norfolk, Essex, and parts of Lincoln (Lindsey).

The POTATO target for 1949 for England and Wales shows little change and it remains just over 1 million acres. The fixing of county targets has, however, been no easy matter, because the Ministry has tried to reduce the acreage in those counties where it is known that the potato eelworm is spreading. The targets have been reduced, compared with 1948, in counties such as Lancashire, Lincolnshire, the Isle of Ely, and Bedfordshire, because the proportion of land growing potatoes on some farms has been very high with a consequent high eelworm infestation, and it is now desired to give some of it a thorough rest to ensure that it shall again be fit to grow heavy crops of potatoes in the future. To compensate for these reductions in acreage, it has been necessary to ask farmers elsewhere to budget for increases in their potato acreage and to regard potatoes as a permanent crop in the rotation. Many counties, particularly in the Midlands, where few potatoes were grown before 1939, showed during the war that they can produce good crops. No longer is it wise or safe for potato-growing to be concentrated in a few areas; the eelworm has brought that era to an end. In future we must spread the potato crop, so suitable to our climate, and so valuable a source of calories, more widely over the country.

LINSEED is still a comparatively new crop for this country, and farmers' programme for 1949 will probably be influenced by the results obtained this year. The acreage of linseed planted has been much lower than had been hoped, but most of the crops look well; a dry harvest, to facilitate cutting and threshing, would do much to encourage farmers to grow this crop in the future. The new varieties from Canada, namely "Royal" and "Redwing," are being grown for the first time on a commercial scale in this country, and their ability to give high yields and even ripening should do much to make them popular for sowing in 1949. The target set for 1949 is 200,000 acres, and Agricultural Executive Committees are being asked to stress the necessity of securing the maximum acreage; the oil is badly needed for industrial purposes, and the by-product—linseed cake—is just as necessary for feeding to livestock in view of the world shortage of oilcakes.

A target of total TILLAGE acreage has been set for 1949 as well as acreages of wheat, potatoes, and sugar beet ; this is being done to ensure that other crops for direct human consumption and forage crops for livestock are kept at as high a level as possible.

Farmers may be assured that the possibilities and difficulties of each county were properly considered before targets were fixed, including the supply of labour and machinery. A considerable measure of help from County Agricultural Executive Committees will continue to be available to farmers who cannot do without this assistance.

While targets have necessarily to be set in acres, the real measure of success is total output in terms of tons of potatoes or grain, pounds of meat or gallons of milk. Increased yields can be obtained by good and timely cultivations, adequate use of lime and fertilizers, both on grassland and arable, the choice of the right varieties for the particular type of land, and so on. The N.A.A.S. and members of County and District Committees are anxious to help in every way they can, and if the £100 million expansion programme is to be achieved, there must be the closest collaboration between farmers, County Committees and the Advisory Service to secure full use of all our resources.

Prices for 1948 Cereal Crops The average prices for cereal crops harvested in 1948 and 1949 were published in an announcement on the Agricultural Expansion Programme issued by the Agricultural Departments on August 21, 1947. The seasonal scales of prices for wheat, oats and millable dredge corn have now been agreed with the National Farmers' Unions and the new prices, which are set out below, apply to all grain sold for delivery on or after August 1 next.

Under Part I of the Agricultural Act, 1947, which came into effect on March 31 last and applies to crops harvested in 1949, the crop year begins on July 1. The scales set out below therefore cover the period to June 30, 1949 ; the price for wheat, oats and millable dredge corn in July, 1949, will be fixed when the seasonal scale for the cereal year 1949–50 is agreed.

WHEAT

For delivery during :	Millable fixed price *per cwt.*	Non-Millable maximum price *per cwt.*
1948	*s. d.*	*s. d.*
August-September	21.9	19.3
October-November	22.9	20.3
December	22.11	20.5
1949		
January	23.1	20.7
February	23.3	20.9
March-April	23.9	21.3
May	23.11	21.5
June	24.1	21.7

POTENTIALLY MILLABLE WHEAT. The maximum deduction for conditioning potentially millable wheat is 2s. 6d. per cwt. from the price for millable wheat.

Oats

	Milling Oats (maximum price) *per cwt.*	Feeding Oats (maximum price) *per cwt.*	Milling and Feeding Oats (minimum price) *per cwt.*
For delivery during :			
1948	*s. d.*	*s. d.*	*s. d.*
August-September	19.11	19.8	18.3
October	20.1	19.10	18.3
November	20.1	19.10	18.5
December	20.3	20.0	18.7
1949			
January	20.7	20.4	18.9
February-March	20.11	20.8	18.9
April-May	21.3	21.0	18.9
June	21.5	21.2	18.9

Dredge Corn

Millable barley dredge corn :	Maximum price	30s.
	Minimum ,,	20s 2d.

Millable dredge corn, other than barley dredge corn ; maximum price per cwt : the same seasonal scale as the fixed price for millable wheat. Minimum price : 21s. 9d. per cwt.

Non-millable dredge corn : maximum price 14s. 6d. per cwt.

Non-millable dredge corn consisting solely of mixed pulses : maximum price 22s. per cwt.

Barley

Barley for malting or other human consumption :	maximum price	30s.	per	cwt.
Millable barley :	minimum ,,	23s.	,,	,,
Potentially millable barley :	minimum ,,	20s. 6d.	,,	,,
Feeding barley :	maximum ,,	14s. 6d.	,,	,,

Rye

Millable rye :	fixed price	23s. per cwt.
Non-millable rye :	maximum price	23s. ,, ,,

Unless otherwise indicated, prices are constant throughout the season. Acreage payments in respect of wheat and rye will be at the rate of £3 per acre on the first 10 acres.

Marketing of Home-Grown Linseed As already announced, the Home-Grown Linseed (Control) Order, 1948, was made by the Minister of Food for the purpose of regulating sales of home-grown linseed. The Order which came into force on May 18 prohibits :

(a) the sale of home-grown linseed by a grower except to an approved buyer, (i.e., a person licensed by the Minister of Food under the Order) or to the Minister,
(b) the purchase of home-grown linseed from a grower by any person except an approved buyer,
(c) the sale of home-grown linseed by an approved buyer except to the Minister of Food,
(d) the use of home-grown linseed for stock feeding except for the grower.

The Order does not prohibit transactions in seed for sowing which are governed by the Growing of Seed Crops (Control) Order, 1948.

Licences have been granted to all persons who are already licensed by the Minister of Food to buy home-grown grains for re-sale. Other merchants who wish to be licensed as approved buyers should address their applications to The Director of Oils and Fats, Ministry of Food, London Road, Stanmore, Middlesex.

A grower (if he wishes to sell direct to the Ministry of Food) or an approved buyer having linseed for disposal should get in touch with the nearest office of the agents of the Ministry of Food—The National Association of United Kingdom Oil and Oilseed Brokers Ltd.—at the following addresses:

(a) Stone House, Bishopsgate, London, E.C.2. (Bishopsgate 6533).
(b) District Bank Chambers, 14, St. Stephens Street, Bristol, 1. (Bristol 242423-4-5)
(c) Tower Building, Water Street, Liverpool, 3. (Liverpool Central 4551).
(d) 96, Buchanan Street, Glasgow, C.1. (Glasgow Central 3991).
(e) Friary Chambers, Whitefriargate, Hull. (Hull 36697).

The Ministry's agents will then advise the grower or approved buyer of the address of the crushing mill to which the seed should be consigned and, where requested to do so by a grower, will arrange transport. Ministry of Food rail consignment notes will be supplied by the agents in cases where it is desirable to consign by rail.

The weight will be ascertained at the receiving crushing mill and a certificate (in duplicate) showing the weight and terms of purchase will be issued to the grower or approved buyer. The original certificate should be returned to the agents of the Ministry of Food, accompanied by the seller's invoice for the sales value of the seed and the cost of any transport, etc., incurred by the seller. After verification, the Ministry of Food will effect settlement direct with the seller. The approved buyer will insert in the copy of the certificate the name and address of the grower; this copy will then serve as an authority for the issue of ration coupons to the grower, in England and Wales by the local Agricultural Executive Committee and in Scotland by the Department of Agriculture for Scotland. These coupons will enable him to purchase 1 cwt. of linseed cake for each 3 cwt. of clean linseed delivered to the mill. This additional supply of cake is for use only by the farmer by whom the linseed was grown; it is an offence to transfer coupons or cake to another person.

Prices and Conditions Payment will be made for the weight certified as having been received at the crushing mill, except where there is independent evidence that the dispatched weight was greater than the weight certified at the mill, when payment will be made for the dispatched quantity.

As already announced, the price payable by the Ministry of Food for the 1947 crop is £45 per ton net weight ex farm, sacks included for linseed of fair average quality, with a deduction of 15s. per ton if returnable sacks are used.

From August 1, 1948, the Ministry of Food's buying price to the grower will be advanced to £55 per ton net weight ex farm. This will be the standard price until further notice and is based upon linseed of 90 per cent purity. A sample from each delivery will be taken at the crushing mill and analysed by the Incorporated Oil Seed Association, and the price payable will be increased or decreased, as the case may be, by 11s. per ton for each 1 per cent of linseed above or below the standard of 90 per cent. For this purpose oilseeds, other than linseed, included in the bulk will be assessed at half the value of linseed, i.e., 5s. 6d. per ton for each 1 per cent.

The cost of non-returnable sacks or of hiring returnable sacks will be added to the standard price of £55 per ton, which will thus be calculated on the net weight of seed delivered. Growers or approved buyers may obtain supplies of suitable sacks from the agents of the Ministry of Food. There will be no charge for the use of these, but the borrower must undertake to return all the sacks or to pay 2s. for each sack not received at the mill.

Rations for Autumn Calvers A special issue of ¼ cwt. protein and 1½ cwt. cereal for each cow or heifer due to calve in October or November will be available, on application, to assist winter milk production. These special rations can be obtained either as straight feedingstuffs or as a compound, arrangements having been made for a special compound "National Cattle Food No. 4," suitable for the purpose, to be obtainable against coupons surrendered in the proportion of one protein to six cereal. The issue will be made in August coupons (valid also for September). Applications should state the number of cows and heifers due to calve in each of the months October and November and should be made to the appropriate Agricultural Executive Committee as early as possible and not later than August 14. Farmers should note that applications received after that date will not be accepted.

World Health Organization The World Health Assembly in Geneva is the first annual meeting of the World Health Organization—the international body charged by the United Nations with responsibility for all the international aspects of health. These are more numerous and of more direct significance to you than you might expect.

On July 22, 1946, a date which many believe will have its place in history, sixty-one nations—probably the largest number of nations who have ever agreed on a set of principles—signed the Constitution of the World Health Organization. Two others agreed later. The organization was deliberately called the *World* Health Organization because these sixty-one nations recognized that those problems of health which are no longer purely national must be solved by international action and on a world-wide basis. Governments have long realized that they are not able to deal with certain epidemics independently, because these epidemics are apt to treat national frontiers with a fine disregard for political considerations and it had been remarked by more than one epidemiologist that bacteria cannot read. During the past fifty years, a number of international health organizations were built up, none of them complete but all serving useful purposes.

The constitution of the World Health Organization embodies the experience gained by those organizations. But it also gives ample evidence of much independent thinking, and it is one of the highest manifestations of that great post-war upsurge of international conscience which produced the United Nations itself.

* * *

FACING THE PROBLEM OF MALNUTRITION As you know, one of the greatest problems which faces the world today is the problem of ensuring adequate nutrition for a rapidly expanding population. The Food and Agriculture Organization of the United Nations has asked W.H.O. to collaborate in promoting food production in the under-developed areas of the world by campaigns against such diseases as malaria, bilharziasis, tuberculosis and so on, which interfere with productivity. Malnutrition may well be classified as the most ancient, widespread and recalcitrant condition the world knows, and the resources of every competent agency must be marshalled against it. It is not commonly realized that the productivity of the agricultural labourer in some of the under-developed areas, especially in the tropical countries, is appallingly low. He works for twelve or thirteen hours a day and his output, even

making allowances for his primitive tools, is unlikely to exceed 15 per cent of his brother's in more fortunate countries. Why is this? He, or she, is usually a perambulating pathological museum. He usually exhibits a startling collection of bacteria, parasites, and chronic debilitating diseases. Malaria is perhaps the most spectacular example of this anachronistic state of affairs, but it should be remembered that hook-worm and other infections are also major causes of such low productivity—in fact, not only of low productivity, but also of that lack of real self-respect which is certainly a root cause of the alleged shiftlessness of these people. If they can be given the belief that man can and does control his own environment, then surely a foundation of real self-respect and enterprise will have been laid for that new and better life which these dwellers in under-developed areas are expecting.

Our Interim Commission has to its credit an outstanding record of international cooperation. Under the chairmanship of a distinguished Yugoslav professor of public health, and representative of eighteen governments including the United Kingdom, China, France, the United States, the U.S.S.R., India and Peru, Norway and Egypt, Brazil and the Ukraine, it has repeatedly reached agreement on many technical and detailed problems, in every case unanimously and without recourse to voting. It is in this spirit and in pursuit of the objective laid down in the Constitution, namely, "the attainment by all peoples of the highest possible level of health," that the voting delegates of over fifty nations and observers from about twenty others are now meeting in Geneva.

DR. WILLIAM P. FORREST, *speaking on the B.B.C. Third Programme, June* 23, 1948.

British Agricultural Bulletin The problem of ensuring an adequate supply of food to the increasing population of the world is one which will exercise our minds for many years to come. F.A.O. has calculated on present population trends that the existing rate of the world's food production will have to be doubled within the next twenty-four years if all the people then likely to be alive are to be fully nourished. It is a monumental task, calling for close international collaboration and the widest possible dissemination of practical agricultural knowledge.

The new quarterly publication of the British Council, *British Agricultural Bulletin*, is designed to help in this respect by placing British farming knowledge and experience at the disposal of other countries. Apart from agricultural institutions and official bodies in this country, this publication is intended for overseas' circulation only. The price is 5s. per issue (subscription for four issues, 15s., including postage) on application to the Publication Manager, *British Agricultural Bulletin*, 3 Hanover Street, London, W.1.

OFFICIALLY APPROVED INSECTICIDES AND FUNGICIDES

Since the date of the publication in the January, 1948, issue of *Agriculture* (p. 478), the following names of proprietary products have been added to the approved list under the Ministry's approval scheme.

Wetters and Spreaders :		
Agral LN	Plant Protection Ltd.	**L 260**
Petrosol 33	Petromor Ltd.	**L 244**
DDT Insecticides to be used as Dusts :		
Buggé's DDT Powder (5% DDT) No. 2	Buggé's Insecticides Ltd.	**AD 225**
DDT Insecticides to be used as Sprays :		
Buggé's DDT Emulsion (20% DDT)	Buggé's Insecticides Ltd.	**AE 226**
DDT Dispersible Liquid (PP)	Plant Protection Ltd.	**AE 246**
DDT Dispersible Powder 25% (PP)	Plant Protection Ltd.	**AE 250**
Benzene Hexachloride Insecticides to be used as Dusts :		
Agrocide 2 (PP Wireworm Dust)	Plant Protection Ltd.	**AK 256**
Stock Emulsion Benzene Hexachloride-Petroleum Oil Winter Washes :		
Agrocide Winter Wash—Winter Petroleum containing Gammexane	Plant Protection Ltd.	**AN 257**
DNC-Petroleum Oil Winter Washes :		
Abol DNC Winter Wash	Plant Protection Ltd.	**AZ 254**
Capsine DNC Petroleum Winter Wash	Plant Protection Ltd.	**AZ 255**
Calomel Dusts (4%) :		
Berk's 4% Calomel Dust	F. W. Berk & Co. Ltd.	**BB 248**
Calotox (*for the control of onion white rot*)	F. W. Berk & Co. Ltd.	**BB 249**
PP Calomel Dust 4%	Plant Protection Ltd.	**BB 251**
Banding Greases :		
Stictite	Plant Protection Ltd.	**BD 258**
Prepared Grease Bands :		
Stictite Ready Prepared Grease-bands	Plant Protection Ltd.	**BE 259**

Products M 147 *and* N 148 *have been withdrawn from the list by the manufacturers.*

A leaflet giving the list of products approved up to January, 1948, may be obtained on application to the Ministry of Agriculture, St. Andrew's Place, Regent's Park, London, N.W.1.

Ministry of Agriculture and Fisheries,
Plant Pathology Laboratory,
Harpenden, Herts.
July 14, 1948.

BOOK REVIEWS

Rothamsted Experimental Station Report for 1946.

The Rothamsted Report for the war years, published a year ago, summarized the work carried out in the period 1939-45, in which part of the research programme was interrupted in favour of *ad hoc* and short-term investigations concerned with the food production campaign.

The report for 1946* follows the pre-war practice of issuing an abridged report (i.e., with tables and detailed experimental data omitted) covering a year's progress. It contains, as one has come to expect, much of importance to the specialist and of interest to the general reader.

For convenience the year's progress is surveyed in the form of separate reports from the heads of each specialist department, but in practice there are no water-tight divisions, each department lending appropriate assistance as the occasion demands. Nevertheless the existence of a background of fundamental and specialized research is emphasized by the summaries of scientific publications by members of the staff, which are a feature of the report: these summaries give a clear insight into the nature of the research problems discussed in the departmental reports.

The report includes, also, one or two reviews dealing in greater detail with special lines of investigation. In this instance they cover natural evaporation (involving a reconsideration of current views on surface tillage in relation to soil moisture), micro-organisms capable of selective destruction of soil bacteria, and take-all disease of wheat and barley

Among the varied subjects covered in the report, the following may be mentioned for their general interest and immediate bearing on farming practice.

The setting up of extra-mural field experiments has been a long-established policy of Rothamsted : experiments in progress on these lines include those begun in 1944, in which the effects of deep versus shallow ploughing are being compared through a complete crop rotation at widespread centres, with the help of farmers and county and advisory staffs. Experiments on the manurial requirements of peas for canning or packeting on which little is known in this country, and on forest nurseries, are also reported.

The residual value (of fertilizers and feedingstuffs) tables last revised in 1913 by Voelcker and Hall have been brought into line with modern changes in farming practice, on the basis of long term experiments at Rothamsted and Woburn.

A survey of fertilizer practice, started during the war, which brought to light hitherto unsuspected discrepancies between the farmer's use of fertilizers and their best economic use, is being extended. (Two new statistical surveys of this type, on milk production and on potato growing, are now in progress in collaboration with the N.A.A.S.).

Recent changes at Rothamsted recorded in the report include the setting up of a Pedoogy department, and of separate Bee and Biochemical departments. The headquarters of the Soil Survey of England and Wales is now centred at the Station.
It is hoped that the 1947 report will be issued before the end of the year.

A.J.L.L.

Plough and Pasture. E. Cecil Curwen. Cobbett Press. 7s. 6d.

The origin of any of the simpler things of life is always difficult to determine. It is no small achievement, therefore, that Mr. Curwen should have been able to present so convincing a story in a little over a hundred pages.

From the days of the wandering food-gatherers to those of settled agriculture, he traces the progress of man's acceptance and use of his environment. The simple seed-bearing grasses from which he used to collect his food were gradually domesticated and cultivated by men living in the natural habitats of these grasses. As much can be said for the hunters who followed the seasonal migrations of wandering herds of wild oxen, sheep and hogs, and gradually domesticated them.

As Mr. Curwen puts it, when man gained knowledge of the reproductive processes of plant and animal, and was able to control them in order to use the result, settled agriculture came into being. The story, as he unfods it, is fascinating, and the book deserves a large public.

G.E.F.

---

*Obtainable from the Secretary, Rothamsted Experimental Station, Harpenden, Herts, price 3s.

BOOK REVIEWS

The Scientific Principles of Grain Storage. T. A. OXLEY. Northern Publishing Co. Ltd. 8s. 6d.

During the period between the wars, grain, whether home-grown or imported, was usually stored for only short periods in this country. An assured steady supply of grain, combined with the necessity of reducing costs to the minimum, meant that it passed rapidly from ship or farm to mill or factory. It was thus unnecessary to give much study to prolonged grain storage and the industry was largely conducted on a traditional and empirical basis.

The decision to set aside stocks of wheat in 1938, and the subsequent necessity for long-term storage during the war, led to the study of the problem, particularly in regard to prevention of infestation by insects and mites. Mr. Oxley was one of the original members of the staff of the Pest Infestation Laboratory of the Department of Scientific and Industrial Research, which was set up in 1940. From the first he adopted a different approach from that used by previous workers. Instead of studying the insects primarily he made an examination of the physical and biological properties of grain in bulk and then used that knowledge to explain some of the changes which take place during storage, including those resulting from infestation. This new approach was very successful in explaining, in particular, the role of insects in inducing heating of grain. The development too, in cooperation with R. W. Howe, of the "carbon dioxide production test" (chapters 9 and 10) for measuring the degree of infestation of grain by immature stages of weevils and other insects, was a great advance, and the method is used by the Infestation Division of the Ministry of Agriculture as a routine test of bulk grain.

Mr. Oxley's book has appeared at an opportune time in view of the increasing interest in the drying and safe storage of home-grown grain. Chapters 3 to 6, which deal mainly with the water relation of grain and with the scientific principles of drying, will be of particular assistance to those operating drying plants. A number of widely held fallacies regarding the value of ventilation as a means of drying grain are exploded by Mr. Oxley, who sets out clearly the essential basis of proper and economical drying.

The extension of combine harvesting raises the new problem of storing the English wheat crop in bulk instead of in the stack. Whereas grain stored in the stack dries out slowly and is not liable to attack by insects and mites (although severe damage may occur from rats and mice), that stored in bulk is liable to severe and rapid deterioration if the moisture content is too high and if attacked by insects or mites. Although Mr. Oxley has suggested, in his preface, that this book should be taken as a starting point for further research, there is little doubt that there is a real need for the better dissemination of existing knowledge of this subject and this book will do much to fill this gap. It will be specially welcomed by all concerned with the handling, drying or storage of grain.

A companion volume to the present book dealing with the principles of prevention and control of infestations by rats, mice, insects, and mites would similarly be of the utmost value.

J.A.F.

Land for the Small Man. NEWLIN R. SMITH. Kings Cross Press, New York. (Oxford University Press). 20s.

This is an admirable and exhaustive survey of the measures undertaken by the State and local authorities during the past sixty years to place men on the land. With a wealth of information and apt comment Mr. N. R. Smith has followed the course of legislation, from the Allotments Act, 1887, to the almost abortive Agricultural Land Utilisation Act, 1931. He has delved deeply into the origins of this legislative programme, which he finds in the propaganda—private and political—that followed the early nineteenth century enclosures. His treatment is objective and free from bias, and his judgments are shrewd and instructive. In a final chapter on "Hopes and Results," the author concludes that, on the whole, the results achieved by fifty years' effort are not very impressive. Despite his rather adverse conclusions he observes very truly (p. 230): "Probably a limited public provision of smallholdings will be continued as a necessity of practical politics."

Mr. Smith has erred in attributing the decline in privately provided smallholdings to the creation of statutory holdings. Social and economic changes in the countryside and the absorption of small units by the growth of towns are the principal factors.

There is some inconsistency in treating equipped holdings provided under the Act of 1919 as both "subsidized" because the rents did not fully cover the cost of providing them (p. 198) and let at a "premium" because the rents naturally exceeded those of the farms out of which the holdings were formed (p. 226). The terms of compulsory purchase or hire of land were not (as stated on p. 80) included in the compulsory Order, but

were determined subsequently by agreement or arbitration. Minor errors include an arithmetical one on p. 14, several wrong reference numbers in Table 12 and footnote, the omission of Devon from the Registered list on p. 215, and an error in the comment on p. 135 preceding Table 11. In describing the provision of land for unemployed industrial workers, the author omits to mention the novel experiments in cooperative market gardening undertaken by the Welsh Land Settlement Society.

A longer digestion of the material collected so assiduously by the author might have given us an even better book.

C.W.S.

The Agricultural Engineering Record. Summer, 1948. H.M. Stationery Office 1s. (1s. 1d. by post).

There has been a renewed interest in the artificial drying of green crops in recent months, particularly as steel can now be allocated for the manufacture of grass driers. Until now, however, there has been a lack of authoritative information on the technique employed by users of grass driers in England and Wales. In the summer, 1948, issue of the *Agricultural Engineering Record*, the results are given of a preliminary survey made by the National Institute of Agricultural Engineering of more than a hundred driers. Interesting information was collected on such points as location, output, length of drying period, labour, field equipment and disposal.

Other work by the N.I.A.E. reported in the same issue has been directed towards the development of a topper-picker for sugar-beet harvesters. A unit was designed and tested that worked efficiently under both wet and dry conditions, and left the tops comparatively free from soil—a feature that should make it particularly suitable for farmers wishing to feed the tops to stock.

Mr. John Higgs of Reading University, who spent four months in Scandinavia last year on a Ministry of Agriculture travelling fellowship, has contributed a well-illustrated description of farm buildings in Sweden and Denmark. Other articles include a discussion of the implements available for deep tillage, results of surveys on hay—and silage-making, and an account of a sugar-beet seed rubbing machine made for the Norfolk Agricultural Station.

Summaries of reports on machines recently tested by the N.I.A.E. and described in this issue of the *Record* are the Dening transportable saw-bench, Leverton potato shaker-digger, Collinson twine-tying attachment for balers, Trusstight baler twine, Claas combine harvester, the Barford Atom horticultural tractor, and the Fowler Mk. V diesel tracklaying tractor.

The Rhododendron Year Book, 1947. The Royal Horticultural Society. 8s. 6d.

The second Year Book to appear under the auspices of the Royal Horticultural Society's Rhododendron Group maintains the high standard of the Society's publications. Well-known rhododendron authorities discuss rhododendrons in North Wales; in Burma, Assam and Tibet; in Europe, New Zealand, in the Pacific North-West and on Mount Omei in Western China. Botanical contributions, dealing with the Anthopogon Alliance, the distribution of rhododendrons and some observations on the classification of the genus by Captain F. Kingdon-Ward, are all of great interest to serious students. The Year Book is illustrated with many beautiful photographs.

R.H.

3642 Wt. 15 CN&Co 8/48 466

Please mention the JOURNAL *when corresponding with Advertisers*

Please mention the JOURNAL *when corresponding with Advertisers*

Please mention the JOURNAL *when corresponding with Advertisers.*

Agriculture

PUBLISHED 6d MONTHLY

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

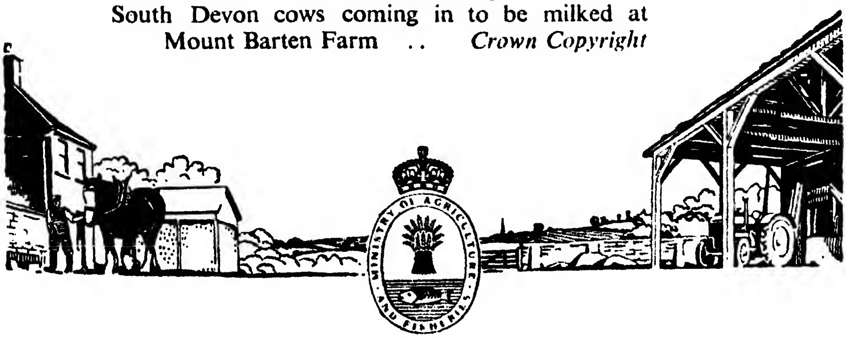
Editorial Offices: St. Andrew's Place, Regent's Park, N.W.1 (*Phone: WELbeck* 7711)

VOL. LV No. 6 SEPTEMBER 1948

Contents

Cover Photograph

South Devon cows coming in to be milked at Mount Barten Farm .. *Crown Copyright*



AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LV | No. 6 | SEPTEMBER 1948

PASTURES OLD AND NEW

THE ANIMAL'S POINT OF VIEW

SIR R. GEORGE STAPLEDON, C.B.E., M.A., F.R.S.

DURING the period since April, 1947, I have been fortunate in having had numerous opportunities for making observations on animals grazing on leys and on permanent pasture and examining the swards. Perhaps even more enlightening has been the many discussions I have had with practical men on the behaviour of their animals. In this short article, which is not based on critical and controlled experiments, it is only my intention to discuss the question in general terms, with a view to emphasizing certain principles which I think emerge. My aim is to create interest in what is an exceedingly complex subject, and as far as I can to suggest fruitful lines of research, and to indicate directions in which the practical man should cast his observant eyes. My own reaction to my own observations is that, no little of the current dogma in respect of grassland management and animal nutrition is overdue, if not for revision, then at least for critical scrutiny.

Outstanding Differences between Permanent Pasture and Leys

The modern ley frequently consists of but one grass and one clover species, and today seldom includes more than half a dozen species. The "better" the ley the fewer the "weeds". The "best" leys frequently contain no "weeds" whatsoever in any eatable quantity. Permanent pasture usually contains a great number of species (nearly always well over a dozen, and often over fifty) a large proportion of which will be in eatable amount. Perhaps of more importance is the fact that the "best" ley will contain only representatives of two natural orders of plants (the grass and clover families), while permanent pastures will contain many. The majority of edible herbs have a high mineral content. Some are nearly as rich in calcium as the clovers ; most are decidedly richer than the grasses in this element. Many are notably rich in phosphates and potash. A herbage consisting of several natural orders would probably contain a wider range of trace elements and of essences than one merely of grass and clover. Under current methods of "good" management the "best" leys will only offer the animal a herbage in one stage of growth ; the permanent pasture will offer the animal eatables in a wide range of growth stages. The chemical composition of a plant is very largely determined by stage of growth : this in respect alike of percentage dry matter, fibre and protein and, to no inconsiderable extent, of minerals. The more mature the herbage the higher the concentration of dry matter and fibre and the lower that of protein. The essence of "good" ley management is to force the animal to eat only herbage that is growing very fast. The quicker the

growth the higher the percentage of water of constitution (the lower the percentage of dry matter) in the herbage. Growth is slower on ordinary permanent pasture; and because there will also be more mature herbage, the sum of the eatables will contain less water than that of leys. Animals on leys are therefore usually compelled to "eat" more water per lb. of dry matter than those on permanent pasture.

Animal Instinct The adult human has been at pains, as far as he has trained his instincts, to cultivate his sensitivity to react to what he likes and not to what is good for him. The behaviour of babies, however, indicates that the instinct for selecting what is good is not atrophied in man. The instinct for what is good and necessary (I am of course referring explicitly to food) is probably still strong, even in the most pampered and sophisticated dairy cow, and, without doubt, stronger still in a mountain sheep. It is true that cattle and sheep on occasion will eat plants which are actively poisonous. This, however, may be the unfortunate result of an uninformed search for a nutritional ingredient lacking in the general herbage. On the basis of my own observations I take my stand with Sherman,* who, referring with approval to the verdict of Dr. W. F. Dove, says: "the innately superior animal in a farm flock or herd thrives better in a given environment than do his fellows, largely because he is born with instincts which lead him to make a better-than-average use of what the nutrition environment affords. In other words, his inborn qualities include a superiority of instinctive reaction as to which of the available foods to eat, and in what relative amounts". In what follows then I assume the animal has an instinctive drive, in some animals stronger and in others weaker, to endeavour to satisfy *all* its nutritional needs. The research motto of the late Professor Bateson was "look for the exceptions"; that of the modern nutritionist should be "search for the animal with superior instincts," and then give him any amount of scope, watch him day and night, and then "read, mark, learn, and inwardly digest". Here I may with justice remark that what is sound advice to the research worker is always equally applicable to the practical man.

A warning is necessary at this point. We must always remember that although, for example, a cow may flow with milk during a lactation, or if such is her fate, fatten to order on a diet that is not in every respect nutritionally balanced and complete, it does not by any means follow that the diets in question continued generation after generation would be adequate healthily to maintain the reproductive cycle. Unless we are very much on our guard, the evaluation of pastures by milk yield or liveweight increase without reference to reproduction can easily lead to erroneous and exceedingly dangerous conclusions. For example, are we on safe grounds to assume that a grass diet consisting wholly of lush leys (of the type now generally employed and managed on modern lines) is of itself the best grass diet, or indeed an adequate grass diet on which to maintain a self-contained dairy herd, or for that matter, on which to maintain any self-contained flock or herd? Only at our peril can we ignore the fact that in certain districts and on certain farms difficulties have undeniably presented themselves in respect of the reproductive cycle.

The Animal's Grazing Technique The sheep is more refined in its ability to select than the bovine. The sheep can with ease take an individual plant or an individual leaf. Thus on a ley consisting of nicely mingled white clover and ryegrass

*SHERMAN, HENRY C. The Chemistry of Food and Nutrition. The Macmillan Co., New York (7th Edition), 1946.

the sheep can specialize in either plant—and its partiality is usually the clover. Similarly the sheep, if so minded, can make short work of all the dandelion leaves on a pasture on which this plant is scattered but scarce. The bovine cannot be quite so precise in dealing with well-mingled herbage. When afforded the opportunity the bovine rather selects in patches; the sheep selects both individual plants and patches. The animal's instinct is to roam and to graze in patches, and in my view if we desire to extend the range of plants and the types of pasturage available to the animal, then it is by encouraging this instinct and giving him contemporaneous access to highly contrasting patches that we shall best achieve our ends.* In doing this the time factor assumes great importance, for the animal must have sufficient time and be given sufficient scope to devour an adequate ration of starch equivalent and protein equivalent. This is where the lush ley with grass at the proper growth stage and at the right height comes in. Every bite from such herbage will yield a full reward in terms of the bulk required to satisfy these needs. If the animal is limited in his intake by the number of bites he is good for in the twenty-four hours, it is obvious that the average intake per bite must not drop below a certain minimum weight or he will go short. Access to the ley insures to the animal an adequate sufficiency of protein and starch equivalent, and leaves plenty of time and plenty of bites for the satisfaction of other nutritional needs or for idle exploration. If the animal has access to other patches as well as to those in an "ideal" condition, will he none the less gorge himself and amongst other things of doubtful nutritional advantage, "eat" too much water? I think not, or only exceptionally, provided the animal is given sufficient variety and not forced into evil habits. It is significant that when oat straw is carried daily on to lush leys during the grazing season, not a day passes without the cows sparing time and bites for the straw. I have this evidence on the authority of two dairy farmer friends of mine Now for grazing evidence.

Animal Behaviour on Free (or comparatively free) Range

If animal instinct means anything this is the crux of the whole matter. In order to ascertain what the animal has to "tell us" it is necessary critically to watch individuals with both "superior" and "inferior" instincts the twenty-four hours round, in all seasons and in all weathers. Dr. Boulet did this in respect of sheep in the early days of the Cahn Hill Improvement Scheme. These sheep had access alike to improved, lush reseeded patches (two-three grass species and white clover) and to various types of rough native vegetation. The sheep almost invariably started and ended their daily grazing on the rough vegetation. During the normal working hours of the day they spent practically all their time on the reseeded patches. On very wet days they kept pretty much to the rough native herbage. Under normal weather conditions the sheep devoted much more grazing time to the closely grazed reseeds than to the native vegetation, but they never went twenty-four hours without grazing on the rough areas. This season I have been on at least half a dozen farms where cattle (generally dairy cows) have always had access alike to an area in ley and in permanent grass. In all cases I was informed that the animals moved in a comparatively regular manner from the one type of sward to the other. In one instance the cattle were under observation (from the windows

*From the sward point of view it is extremely difficult, if indeed possible, to maintain one area in a sufficiently varied condition to meet all needs in respect alike of growth stage and wide range of species.

of the house) from dawn to dusk. The old vegetation was here unploughed virgin down (steep banks) and the cattle behaved in a manner very similar to the Cahn Hill sheep. On all farms I was informed that the cattle spent less time on the ley in wet weather than in dry. All this is highly revealing and suggests amongst other things that animals object to "eating" too much water. Rough vegetation, as well as having a higher dry matter content than lush grass, will dry from dew or rain much more quickly.

I draw this tentative conclusion. Animals, if given the chance, graze with discretion. They move from one type of vegetation to another, not only "in search" of particular minerals, shall we say, but because they sense the need of a particular balance between "eatable" water (wet matter) and dry matter ; a particular balance between fibre (and fibre in various stages of digestibility) and high quality, readily digestible nutrients ; a particular balance between different proteins and the attendant amino acids, and so on. I submit therefore, that it is just as important to give the animal access to vegetation in all stages of maturity (degree of maturity being a chemical arbiter of the first importance), as to give him a sufficiently wide range of plants with different inherent and specific chemical properties. These views are, I think, supported by the evidence I am slowly accumulating by watching Devon steers at free range on virgin down pastures, but this is another and unfinished story which I may be able to tell at some later date.

Conclusion The reader may have thought, or gladly persuaded himself, that I am hauling down my colours and now arguing strenuously against the ley. Far otherwise. It is all a matter of balance. If my basal argument is right what we want to know is, the correct ratio in which different contrasting types of herbage should be presented at the same time to the grazing animal. I have discussed this matter with a number of shrewd practical men, men who will never be persuaded to go out of ley farming. If the contrasts are to be arranged for merely by balancing leys with permanent grass, then the general view (of those men who are convinced of the necessity of contrast) is that of the total of grass (leys and/or permanent) on the farm, from one-sixth to one-third should be permanent. How wonderful if on no farm in England or Wales that quota of permanent grass was exceeded ! It seems, however, to be widely overlooked that whatever permanent grass can do in any particular respect, so can the ley be made to do. It is purely a matter of contrasting seeds mixtures (not ignoring herbs) on different fields or parts of fields (= patches) ; while with an adroit use of the electric fence it would be no difficult matter, at all times, to give the animal access to a relatively small patch of herbage in an advanced stage of maturity. And over all hang the dark and threatening clouds of our times. The ley of three years and upwards necessarily means alternate husbandry, and alternate husbandry means crops and grass. There is national safety and rural vigour in alternate husbandry, in which our acreage cannot be too large : there is national peril and rural inertia in permanent grass, the dangers of which in excess have been made woefully apparent in this fateful century.

BLOAT: OBSERVATIONS ON SOMERSET PASTURES

D. R. Bathe, B.Sc.

ALTHOUGH bloat in ruminants was mentioned in agricultural literature over a century ago, there is still little information as to its incidence and severity in animals at pasture in Britain. The condition is not peculiar to this country, however ; it is well known in most parts of the world where cattle are pastured, and particularly where legumes form the basis of herbage feed. Foods other than the grasses and clovers are known to induce bloat, e.g., rape, kale, wheat grain, green lucerne, and finely ground lucerne hay.

Trouble from bloat in pasturing dairy animals in south-west Scotland led to a survey by McCandlish* in the Rhinns of Galloway during 1930. Replies from 152 livestock producers disclosed its prevalence on 34 per cent of the dairy farms.

With the increasing use of rotational pastures in certain dairying districts of Somerset, there seems to be a corresponding increase of bloat. Accordingly during March to October in 1944 and 1945, local inquiries were made to find out more about it. A record was made of all the environmental factors which appeared to bear on the disorder in the hope that some indication as to methods of prevention would evolve.

Observations were confined to a small area in which the previous fatalities in grazing cattle had occurred. This area was centred on Shepton Mallet and embraced 53 dairy herds, totalling 1,166 animals. It has a mean annual rainfall of 32 inches and the main soil types are Keuper marl, lias clay, and alluvium, which, under fair management, support good natural pastures and prolific rotational grass.

Before the war-time ploughing campaign temporary grassland husbandry in this district was confined to very few farms, so that during the observation period it was possible to make regular visits to all herds grazing these new ley pastures. In addition, the writer was responsible for the cultivation and sowing of a number of grass fields without nurse crops and was able to observe closely every stage of herbage development and management. The subsequent grazing management of these fields was dictated by herd requirements, availability of pasture and water, and other factors typical of the small farms in the area. The following data were obtained :

Date	Number Blown	Degree of Bloat			Cows				Heifers	
					Lactating		Dry			
		Marked	Severe	Fatal	Pregnant	Empty	P.	E.	P.	E.
1944										
July 3	60	44	15	1	52	5	3	–	–	–
,, 6	10	9	1	–	10	–	–	–	–	–
,, 15	4	3	–	1	4	–	–	–	–	–
Aug. 24	9	8	–	1	–	–	–	–	6	3
Sept. 19	1	1	–	–	–	1	–	–	–	–
,, 20	1	1	–	–	1	–	–	–	–	–
,, 21	2	1	–	1	1	–	1	–	–	–
1945										
July 16	20	18	–	2	15	–	–	–	3	2
,, 18	4	3	–	1	4	–	–	–	–	–
,, 20	21	19	2	–	18	3	–	–	–	–

*Hoven or Bloat in Dairy Cattle. *West of Scotland Col. Agr.* Bull. 127.

It will be seen from this table that both dairy cows and hiefers are affected and that the condition was most common in July of both years, being more prevalent in 1944. Reports of bloat outside the area under observation during that year were also far greater than those occurring in 1945.

Seven fatal cases were observed—four cows in full lactation and three heifers. These numbers might have been higher but for the timely removal of cattle and subsequent treatment. High-yielding cows appeared to be more prone to an attack than dry or young animals, although cows nearing the end of pregnancy were quicker to reach the acute stages of distress symptomatic of bloat in its critical phase.

Influence of Climate and Herbage Growth Rainfall and temperature were recorded daily from March to September during 1944 - 45, and plotted against herbage growth and grazing periods of certain new-sown swards, some of which later gave rise to bloat.

It was during 1944, when local climatic conditions were very unusual, that the most severe cases of bloat were observed. Dry, hot weather in the early grazing season of that year, with only short heavy falls of rain, followed by rapid evaporation, resulted in slow growth which was quickly eaten.

During March, 1944, only 0.18 inches of rain fell, and from March 1 to May 29, 2.44 inches of rain; at this time pastures throughout the area were grazed bare.

Between May 30 and June 15 of that year 2.04 inches of rain fell; thundery weather conditions after the last date led to prolific clover growth in those leys which had been subjected to close grazing. Early in July severe cases of bloat occurred inside the area of observation and other cases were reported widely from outside.

A contrast in herbage growth was provided in the same year by a 14-acre field sown without a nurse crop to a three-year ley on July 12, and grazed for the first time with 30 dairy cows on August 15. Following intermittent grazing and weather ideal for rapid growth, the grass species were almost completely dominant in this sward, but four animals were severely attacked with bloat when grazing this pasture between September 19-21, 1944, one case proving fatal.

Pastures Conducive to Bloat Only slight cases of bloat were reported on old, permanent pastures, and it did not recur. Affected animals were transferred to these pastures from rotational grass. Bloat was most frequent on three-year leys in the first year of growth, but pastures up to three years old were able to induce bloat. Symptoms were most severe on weed-free, prolific swards sown without a nurse crop, three fatalities resulting on this type of pasture.

Rotational grass aftermath pastures appeared particularly conducive to bloat. Although only two marked cases were observed within the area, and those during 1945, severe and fatal cases have since been reported in the district on this type of pasture, where several weeks elapsed between haying and grazing, thus allowing the growth of lush herbage.

During the observation period, legumes were dominant in all the pastures at the time bloat occurred, with the exception of the one field previously mentioned.

This unbalanced growth of species in the young swards was most noticeable in the area during 1944 and was the consequence of hard persistent grazing, due to scarcity of keep, dry conditions, and the limited grazing area of the small farms.

Effect of Grazing Periods The evening period of grazing was the most dangerous for lactating cows; with the exception of the one heifer which died on the morning of August 24, 1944, every fatal case occurred in herds put to pasture after the evening milking.

In one herd under continuous observation, the time allowed for grazing a new ley was approximately one hour in the morning after milking, and another hour, seven hours later, for evening grazing. During the interval the herd was shut into a sparse old pasture, when the animals showed marked discontent, even refusing to graze. On resuming the feeding of the ley, ingestion was very rapid, and within the hour cases of bloat followed.

The most disconcerting factor was revealed in 1944. Two fields in their second growth year induced bloat after many weeks of continuous grazing by the same animals. In each case, the herbage had been stimulated sufficiently by rain to compete with the rate of removal by grazing.

Effect of Bloat on Economic Herd Management It can readily be realized that the possibility of bloat in cattle grazing rotational pasture constitutes a serious handicap to economic herd management. Further, the confidence of farmers contemplating an increased acreage of young grass was not strengthened by learning of the loss of valuable animals.

In the herds under observation total and individual milk yields were seriously reduced, and with some animals severe scouring lasted up to three days after the onset of an acute attack.

The time spent in watching cattle at pasture and feeding roughage to prevent blowing could ill be spared, veterinary treatment was an added expense, and the possibility of the constitution of animals severely attacked being impaired for life, plus uterine disturbances to the pregnant animal, are other serious factors.

Finally, the apparent necessity of excluding the biennial legumes from leys, owing to their rapid succulent growth under favourable conditions, is already influencing some farmers, and may prove detrimental to herbage fodder production and balanced husbandry.

Avoiding Bloat It is realized only too well that the nature of these observations does not permit the propounding of decisive measures for avoiding bloat, but they may help towards its mitigation or prevention.

Bloat was observed in all ages of dairy cattle at pasture from 12 months upwards, high-yielding cows appeared particularly prone, and heavily pregnant animals were readily subject to acute attack.

The incidence of the disease appears greater during June and July, a point confirmed by other investigators; hot, wet weather in these months calls for constant vigilance.

Climatic conditions seem to be closely related to the onset of bloat. Weather that favours bursts of succulent, non-fibrous herbage, seems liable to cause trouble in any of the growing months.

With young pastures responsive to growing conditions, every care must be taken, especially following dry periods and hard grazing. This should be borne in mind when outlying leys are stocked with young or dry animals receiving only occasional supervision.

Where bloat is feared on first grazing a lush pasture which has been allowed to get out of hand, it is far better to stock the sward with the greatest concentration of animals possible, to reduce the amount of feed available and quickly get the pasture under control. This applies particularly where

intermittent daily pasturing is the normal practice, and places even greater emphasis on the advisability of dividing large fields into controllable pasture units.

To allow hungry cows access at any time to young swards in their full flush of growth, whether after morning or evening milking, is undesirable, and where intermittent grazing is adopted it would seem necessary to ensure that the animals do not go hungry too long, otherwise ingestion during the resumption of ley feeding may be so intense that a bloated condition can readily result. Dairy cows quickly adapt themselves to a routine, and during the observations recorded it was interesting to notice that herds allowed to graze young grass at the same times each day for short periods only, fed ravenously at those times in order to satisfy themselves after being removed ; it might be well to commence pasturing each day on coarser herbage. The reverse practice of feeding the new sward first, followed by removal, makes animals discontented and lowers milk yields.

Night pasturing a dairy herd on young swards during an actively growing period is inadvisable (if it can bė avoided). Herd supervision is then relaxed and following inactive afternoon grazing and milking time, coupled with cooler temperatures, the herd tends to graze too avidly. If this period can be spent grazing coarse fibrous pasture the animal can be left with impunity, and will be safeguarded against digestive troubles when feeding young grass the following day.

Conclusions The risk of bloat in dairy cattle grazing young leys, has become a serious problem on some farms in Britain, and although research is proceeding there is still a dearth of information concerning its prevention on the typical herbage of this country.

Observations in Somerset indicate that the risk of the onset of the malady with accompanying digestive disturbances could be lessened considerably by more careful management.

New pastures are undoubtedly very productive and nutritious, but more attention needs to be given to their economic utilization by the grazing animal.

RESIDUAL MILK

F. H. Dodd, B.Sc. (Agric.) and A. S. Foot, M.Sc.
National Institute for Research in Dairying, University of Reading

IN 1615 Markham (1) wrote: "When she (the dairymaid) seeth all things answerable to her desire she shall then milk the cow boldly and not leave stretching and straining of her teats till not one drop of milk more will come from them, for the worst point of housewifery that can be is to leave a cow half milked, for besides the loss of milk it is the only way to make a cow dry and utterly unprofitable for the dairy".

In this one sentence Markham anticipated by more than three centuries many of the present-day theories concerning efficient milking. The urge to advise on proper milking methods is therefore not new, and several writers since Markham have recorded their opinions concerning this matter.

It is of interest to note that many who have commented in the past, and many who do so at the present time, imply, if they do not state categorically, that efficient milking carried out by an experienced milker is a precise and complete operation, like pouring water from a watering-can. Until recent years there was some excuse for this assumption, for many thought that a substantial proportion of the milk was manufactured by the cow during the act of milking, and it was reasonable to suppose that the efficient milker left the udder virtually empty. It is now known, however, that when a cow is ready for milking the milk is already in the udder *as milk*, and a good deal of evidence has been presented to show that even with a good milking technique a substantial proportion of milk is left in the udder. Thus Hammond ([2]) in 1913 found that the injection of a hormone preparation from the pituitary gland after milking made it possible to obtain about 20 per cent more milk. Gaines and Sanmann ([3]), who studied the amount of lactose in the udder and its contents immediately before milking time, also concluded that there was a discrepancy of about 20 per cent between the milk normally obtained and that which appeared to be in the udder. Later Knodt and Petersen ([4]) and Johansson ([5]), also using injection methods, found substantial amounts of milk and fat in the udder after normal milkings; Johansson's data, however, suggested that the amount of milk retained was not an approximate *percentage* of the milking but a residuum of some 6 to 10 lb., irrespective of yield.

Reading Experiment Further evidence on the amount of milk retained has recently been obtained at the National Institute for Research in Dairying, where a long-term investigation of the milking process is being carried out. In one experiment we have been comparing two milking routines. It was realized when the experiment was planned that differences in milk yield obtained by the milking machine under the two routines would be small and would be of no significance unless large numbers of cows were used. On the other hand, differences in the amount of milk left in the udder on the two routines were expected to be rather large, and if these could be measured there seemed to be a fair chance of obtaining statistically significant results, even with only eight cows if a double reversal lay-out were adopted. It is now considered possible to milk out most of the residual milk immediately following an ordinary milking by injecting the cow with oxytocin and again milking the cow to obtain the so-called super-strippings. In our experiment this was done on each of our eight cows on one morning per week for sixteen consecutive weeks. The average amounts of milk and fat drawn by the ordinary machine milking on this one morning each week, and the weights of milk and fat obtained following the oxytocin injection on the same mornings, are given in the table on p. 241. In each cow there was a good deal of variation from week to week in the amount of super-strippings, some due to the different routines (which will be discussed in another paper) but the important point to note here is that with all eight cows from 71.3 to 80.8 per cent of the "total milk", and from 39.3 to 48.5 per cent of the "total" fat in the udder, was withdrawn by ordinary machine milking. These percentages are based on the assumption that the oxytocin injections caused a complete evacuation of the udder. In so far as this was not the case the percentages would therefore be on the high side. On average the super-strippings contained no less than 13.42 per cent fat.

The cows in this experiment were normal Shorthorns in mid-lactation, giving about 3 to 4 gallons of milk daily. They were milked with an ordinary bucket machine by experienced milkers. The experimental routines were such as would be found on good commercial dairy farms. It seems reasonable

to assume, therefore, that under ordinary farm conditions normal machine- and hand-milking is only *partial* milking; considerable amounts of milk and fat are left in the udder.

It is interesting to speculate on the commercial significance of this fact. In the first place it can be shown that there is a strong tendency to compensate a variation in yield at one milking with a counter variation at the next. This is illustrated by the yields of our eight cows on the day before injection, on the day of injection, and on the following two days. These were:

	lb. milk per cow
Day before injection (p.m.+a.m.)	34.0
,, of ,, ,, ,,	39.0
,, after ,, ,, ,,	29.1
2nd day ,, ,, ,, ,,	34.8

The extra 5 lb. of milk obtained on the day of injection is on average about the same as the deficit on the following day, while on the second day after injection the mean yield reverted to normal. The fairly accurate compensatory effect was observable in all eight cows. This may be used as a valid argument against the "stretching and straining" for the extra drop of milk at the end of a particular milking, but it must not discourage the adoption of an efficient routine. It can be assumed that for any cow the amount of residual milk depends on the completeness of let-down, which is in turn dependent upon the efficiency of the milking routine. The cow's cooperation by improved let-down, rather than her hostility induced by excessive stripping, will therefore be much more effective in reducing the residuum over a period. It is known that the amount of milk normally left in the udder affects not only the current output but has a cumulative effect on future production. Ability to reduce persistently the head of milk in the udder must be an essential qualification of a good milker, and this no doubt accounts for some of the difference between the output of a herd where a good cowman is in charge and that of a similar quality herd where a poor cowman presides.

Effect on Quality The data in the table suggest that an extra 1 lb. per cow might have a marked effect on the fat content of the bulk milk on the particular morning. For example, taking our mean figures, it can be estimated that if to our ordinary milking of 20.29 lb. of milk at 3.23 per cent fat we were able to add 1 lb. of the super-strippings, we should have 21.29 lb. milk at 3.71 per cent fat. It could, of course, be argued that a high fat at one milking would be compensated by a low one at the next and vice versa, but this compensation effect may not be as direct in the case of butter fat as it is in the case of milk. From the point of view of milk quality also there is, therefore, much to be said in favour of keeping the head of milk in the udder as low as possible by good milking methods.

The matter is also of great importance in all cases where a short period test is used to assess, officially or for competition, the cow's producing ability—for example, in milk recording or in show milking trials. Apart from the possible unscrupulous action of leaving abnormal amounts of milk and fat in the udder on the day before an official recording or milking trial, there is clearly considerable scope for increasing output of milk, and particularly of fat, on the day of the trial by honest cooperation between the cow and the milker. A small dip into the super-strippings might well bring a big dip into the prize money! If the cows in our experiment are any criterion of cows in milking trials, it would appear that at the milk-out

MILK AND BUTTERFAT DRAWN FROM THE UDDER FOLLOWING OXYTOCIN INJECTION IMMEDIATELY AFTER NORMAL MILKING BY MACHINE

(Mean of sixteen morning milkings at consecutive weekly intervals for eight cows)

	Mean Weight of Milk		Mean Weight of Butter fat		Mean Fat Percentage		Percentage of "Total" Milk and Butter Fat in Udder drawn by Normal Machine Milking)	
	(a) drawn by normal machine milking	(b) drawn following injection of 10 units of oxytocin immediately after (a)	(a) normal milking	(b) after injection	(a) normal milking	(b) after injection	Milk	Fat
	lb.	*lb.*	*lb.*	*lb.*	*per cent*	*per cent*	*per cent*	*per cent.*
Rosalie 24 ...	18.23	4.90	0.519	0.654	2.85	13.33	78.8	44.3
Lottie 23 ...	22.63	6.04	0.713	0.814	3.15	13.49	79.0	46.7
Clara 12 ...	15.86	3.77	0.416	0.501	2.63	13.29	80.8	45.4
Phoebe 2 ...	26.42	6.75	0.953	1.013	3.61	15.01	79.7	48.5
Rosalie 26 ...	14.34	5.77	0.436	0.673	3.04	11.66	71.3	39.3
Campion 14 ...	23.98	7.67	0.731	0.906	3.05	11.82	75.8	44.6
Olivia	18.41	5.13	0.731	0.789	4.00	15.34	78.0	48.3
Derrit 8 ...	22.47	5.85	0.736	0.809	3.28	13.83	79.4	47.6
Total ...	162.34	45.88	5.241	6.159	—	—	—	—
Mean per cow at morning milking	20.29	5.74	0.655	0.770	3.23	13.42	77.9	46.0

before the trial the judge has the difficult task of ascertaining not that the udder is empty, since this complete evacuation is impossible without the use of injections, but that the milker and cow have cooperated to reduce the level of milk and fat in the udder to that which will be reached after each of the trial milkings.

Finally, it is clear that the extent of the normal residue of milk and butter fat in the udder after milking is of great importance to investigators and advisers who are concerned with the effect of feeding, environment or management on milk yield or quality. Frequently efforts are made to measure differences due to experimental treatment which may so easily be masked by variation in efficiency of milking, and consequently in the amount of milk and fat left in the udder. It is too often assumed that the amount drawn from the udder is a direct measure of the potential secretion into the udder and consequently an accurate reflection of the producing ability of an experimental treatment. Apart from the marked increase in error due to variation in completeness of milking, it must be borne in mind that the experimental treatment itself may affect let-down of milk, and consequently there is a danger of attributing to a treatment an effect on secretion *into* the udder which in fact should be attributed to its effect on our efforts to get milk and fat *out of* the udder.

The writers wish to acknowledge the help of Miss E. Henriques in collection of data and of Dr. S. J. Rowland for arranging analysis of milk samples.

References

1. Markham, G. "The English Housewife" (1615).
2. Hammond, J. "The effect of pituitary extract on the secretion of milk." *Quart. J. Exp. Physiol.* (1913) **6**, 311.
3. Gaines, W. L. and Sanmann, F. P. "The quantity of milk present in the udder of the cow at milking time." *Amer. J. Physiol.* (1927) **80**, 691.
4. Knodt, C. B. and Petersen, W. E. "The effect of complete evacuation of the mammary gland by pitocin upon milk and fat production." *J. Dairy Sci.* (1944) **27**, 449.
5. Johansson, J. "The amount and fat content of residual milk in the udder of high producing cows." *Reprint of paper prepared for the 12th World's Dairy Congress to have been held in Vienna,* 1940.

FARMING SYSTEMS AND POST-WAR PROBLEMS IN THE NORTHERN COUNTRIES

R. O. Whyte, Ph.D., R. L. Crocker, D.Sc., and Professor Martin Jones

An invitation to the writers from the Swedish Grassland and Peat Cultivation Society (Svenska Vall och-Mosskulturföreningen) and the Finnish Grassland Society (Laidunyhdistys) to join a party of Swedish and Finnish grassland specialists in a tour of their countries provided an excellent opportunity to see something of grassland management and fodder production in relation to farming systems, post-war conditions, and current economic trends in Sweden and Finland. In addition, a brief survey of

conditions in Denmark and Norway was made in company with local specialists. This article deals with some of the general agricultural problems; the questions relating specifically to grass farming in these northern countries were the subject of an article in the *Journal of the British Grassland Society*, December, 1947.

In common with many other countries, Sweden has been going through a process of reorganization of agricultural research. The report of a special committee which inquired into it has now been published, and its recommendations are being carried out. One of the chief characteristics of Swedish research on crop and grassland husbandry and plant breeding is the arrangement for regional sub-stations of the central stations. This is essential in a country covering such a wide range of latitude and variations in climate and soil. A group of regional farms resembles in its scope and work the proposed husbandry farms of the N.A.A.S. in this country. Agricultural research in Norway is only now recovering from the upheavals of the war, and the work at the Experimental Farm at As is getting under way again. The centre for research in Denmark is the Royal Veterinary and Agricultural College in Copenhagen. The aim of all research and advisory work in the northern countries is, as far as possible, self-sufficiency in food, fodder, and seeds.

Land Use and Farming Systems The intensity of farming falls as one travels northwards, and the proportion of a farmer's property in forest in relation to his cultivable land increases. In Denmark and Skåne (South Sweden), it is practically 100 per cent arable. In Middle Sweden (latitude of Stockholm and Uppsala) the situation is very different: for example, the eleven farms owned by the company operating the Skultuna property have only 3,000 acres of arable, as against 12,000 acres of forest (pine and spruce); the company operating the Hasselfors land (at the same latitude) has 1,500 acres of arable and 5,000 acres of forest. As an example of a smaller farm, Risslinga, Balingsta, south of Uppsala, has 38 acres of woodland in a total of 85 acres.

In southern Finland it is much the same. The farm of Portaanpää, situated near Salo in south-west Finland, the most intensively cultivated part of the country, has 55 acres, 34 of which are arable and the remainder forest. The position in central Finland, as around Kuopio, is entirely different: Hakulila, a typical large farm, covers 930 acres, of which only 53 acres are not in forest; at Vainikkala, Maaninka, 88 acres out of a total of 280 acres are not in forest.

There is considerable interest in the most economic size of farms. The *maximum* for the new colonization schemes in Finland is about 33 acres arable, whereas legislation now under consideration in Sweden proposes a *minimum* of some 60 acres. This latter area, or something approaching it, is considered to be the minimum required for efficient management and production; 200,000 farms in Sweden would be affected by such new legislation.

Under present conditions forestry is paying well in the northern countries: agriculture is frequently producing at a loss, or is profitable only when heavily subsidized. Anything that interferes with the production of the forest land and with natural regeneration of the trees is therefore important. Forest grazing is a common practice, particularly in Finland and northern Sweden. Though it is found practicable to summer the young stock very cheaply in extensive forests, great damage is caused to the young trees. At the same time the young cattle make much slower progress than when they are enclosed in fields from which the trees have been cleared and pasture herbage encouraged either by manuring alone or by introducing seeding and cultivation along with manuring.

However desirable the dual-purpose use of the land is considered to be

—grass and trees at the same time—the production per acre suffers considerably. Accordingly strenuous efforts are being made to remedy this state of affairs to the ultimate advantage of both the grazier and the forester. The foresters say : "After human beings, cattle are the greatest danger to our forests". To provide grazing on grass instead of in forest land for the one or two cows belonging to the peasants, the Finnish Grassland Society, and subsequently the State, have provided about a thousand communal pastures on which groups of cows can be kept. This action reduces forest grazing to some extent, although the larger farmers still graze their dairy cattle and young stock in the forests during the summer.

Below are given some details of farms of varying sizes visited, to indicate the types of enterprise seen in Denmark, Sweden, and Finland; the general trend from south to north already noted can be seen.

Denmark-Jutland (520 acres)

NORMAL ROTATION : Barley, ley (grazed first year, cocksfoot, or meadow fescue for seed in second), oats, wheat or rye, roots, barley, barley.

SEEDS MIXTURE : (*lb. per acre*) : red clover 8, cocksfoot 6, white clover 1.

FERTILIZER : Superphosphate and potash 200 lb. each per acre, now increasing amount of P. Cows 60, average yield 180 kg. butter fat per cow per year.

Denmark-Jutland (130 acres)

ROTATION No. 1 : 4 years in grass, oats, wheat, roots, barley.

No. 2 : one year grass, oats, flax, swedes, barley, roots (fodder sugar beets), barley.

SEEDS MIXTURE (*lb. per acre*) : No. 1 : English white clover 3, Mors white 3, timothy 10, perennial ryegrass 3, meadow fescue 3.

No. 2 (for hay) : red clover 10, timothy 3, perennial rye-grass 3.

FERTILISERS : 200 lb. per acre phosphate and potash ; hope to double.

Denmark-Jutland (72 acres, 24 acres in permanent grass)

ROTATION : Grass, oats, rye, roots (sugar beet), barley, roots (swedes), barley, roots (potatoes), barley (cover crop).

SEEDS MIXTURE : (1) ley outside rotation (lb. per acre) : timothy 3, *poa pratensis* 4, alsike 2, English wild white clover 5, meadow fescue 10, late perennial ryegrass 6.

(2) ley in rotation : semi-late red clover 10, late perennial ryegrass 2, early perennial ryegrass 2, timothy 3.

Middle Sweden

Company operating eleven farms and specializing in production of timothy seed. 3,000 acres run as seven units and 12,000 acres of forest. Milk production of secondary importance. Irrigated pastures on three units. 600 dairy cows averaging 4,000 kg. or 400-500 lb. per acre. Dairy stock out from May 10 to October 1 (1947).

Central Sweden (85 acres, including 47 arable)

16 cows, 4 young cattle, 3 sows.

CROPS : Barley, rye, timothy/red clover ley for silage and hay, and in addition 14 acres of permanent pasture subdivided into folds, and including some lucerne.

S.W. Finland (1,130 acres, including 306 arable)

38 Ayrshire cows, 8 sows, 9 horses. One tractor.

CROPS, 1947 (*acres*) : Wheat (mainly winter) 39.5, winter rye 10, barley 33, oats 34, sugar beet 25, fodder beet, kohlrabi and red beet 1.25 each, potatoes 8.5, temporary grass ley 125 (first year 31, second 52, third year 42), fallow 13, for use of labourers 12. Average yield per cow 1938-39 4,577 kg. 1945-46 (absence of cake) 3,783 kg ; grazing period June 8 to September 30. Total amount of fodder—3,008 fodder units.* 300 acres tile-drained. Main rotation : 3 years of ley, winter wheat, sugar beet, barley or spring wheat.

---

*1 fodder unit = 1 kg. barley or 1.1 kg. dry solids in roots or other feedingstuffs, with a milk production value of 0.75 kg. In practice, 1 food unit corresponds to 0.7 kg. starch equivalent, on an average.

Nils Hansson. A comparison of the present-day measures of the productive value of feedingstuffs, and the nutritive requirements of domestic animals. Washington (1924).

Central Finland (1,050 acres, including 60 acres arable and 87 acres rough grazing, almost all woodland grazed)
17 dairy cows.

CROPS (*acres*): Spring wheat 2.0, winter rye 3, barley 2.5, oats 6.8, roots 0.25, potatoes 2.0, temporary grass leys 35, misc. 3.0. Average yield per cow 1939, 2,413 kg. Grazing period June 1-October 10.

Fodder Provision Owing to the short growing season, the overriding need with all stock farming in these northern countries is the provision of winter fodder. In the past very large areas of roots have been grown, but the high cost of labour during recent years is reflected in the present trend away from these crops, and more attention is now being devoted to grassland products.

The first step in this direction was an improvement in the quality of hay. This has been attained by the use of the Swedish fence method, which ensures green hay of high nutritive value, even in wet districts. Experiments to compare the cost of production and feeding value of different crops have included those, now classic, carried out at Boda and Blombacka. The comparisons were based on the cost per fodder unit over a period of nine years. They showed that fodder units in hay cost twice as much as the corresponding units in grass as pasture. The comparison between roots and pasture was still more unfavourable.

The greatest difficulty—that of obtaining the necessary protein in winter—still remained. Apart from making grass silage, this was met by growing oil seeds such as linseed and poppy. Denmark had made a fair amount of progress in this direction even before 1939, and was therefore able to acheve a certain measure of self-sufficiency during the war.

Pasture Irrigation In these northern countries not only is the summer growing season rather short but it is frequently marked by a period of drought. In many districts the fodder deficiency in summer has been partly met by breaking into the area set aside for the winter supply, thus aggravating the situation the following winter.

In other areas special crops are grown for soiling purposes, but the most economic and effective way is by irrigation with a rotating sprinkler which can be moved from one point to another on a pipe which lies on the surface of the pasture. The pump and 400 yards of piping plus sprinkler cost about £400. The dividend on this is very high, particularly in a year of drought, since it saves the whole situation as far as the dairy herd is concerned. No other provision by way of fodder production can touch it for economy in dry years. Examples where this system played an important part in overcoming the summer drought in 1947 could be seen in Sweden and Finland. Irrigation usually begins about the middle of June, and production from the pastures is enhanced considerably—such as, from 2,500 to 3,700 fodder units per season. What is still more important is that wherever sufficient water is available, this method is not only the most economic but also the most reliable for maintaining the milk yield of a dairy herd.

Post-war Land Problems in Finland As a result of the loss to the Soviet Union of about a tenth of her area, mostly in Karelia, Finland is faced with a major problem in the rehabilitation of a large farming population. This is being tackled with great vigour. The necessary land is found from State, parish and company land, from large farmers, and from farms owned by people with another source of income. A 450-acre farm would lose about 100 acres plus 75 per cent of the area over 250 acres, i.e., a loss of about 230 acres. One

company has lost a total of 4,500 acres agricultural and forest land, including 800 acres of their 1,000 acres of arable; the maximum size of farm granted to the "colonists" is about 33 acres arable, but the range is from 5 to 33 acres arable. Communal grazings are provided, as well as enough woodland to yield an adequate annual return. The State generally erects the farm buildings, and the tenant pays off their cost in due course; settlers can build their own. Difficulty is experienced in adapting existing buildings, which are generally too big for the units they are now intended to serve. "Colonists" are selected and settled as far as possible in their original social or village groups.

Increase of Agricultural Production and Efficiency Theoretically it would be possible to clear enormous areas of forest for agricultural or grazing land but this land represents too valuable an economic asset to be used in this way. It is therefore more desirable to intensify production from existing agricultural land and to reclaim non-forested land. In Sweden the greatest potential increase might be obtained from the peat land, of which there are many types. One-sixth of the present agricultural area of Sweden is on peat.

Considerable advantage can be derived in Finland from the replacement of the many parallel open field drains by sub-surface drains, which gives land the ridge-and-furrow appearance characteristic of the English Midlands. Open drains are so common in some districts that their removal would increase the available crop area by a tenth or more. The more progressive grassland specialists and farmers are aware of this, but labour costs make it increasingly expensive as time goes on. The open ditches are frequently cut by scythe to provide a hay crop, but it is very weedy.

Reclamation in marginal areas demands new or better adapted strains and varieties of grasses, particularly in North Sweden and Finland. Special stations in North Sweden will attend to this problem. An interesting breeding project at Svalöf is directed towards the production of wheat x rye hybrids which will grow on non-wheat soils and yield flour with an adequate baking quality—as near to that of wheat as possible.

The greater intensification of grassland production is likely to follow an extension of the use of irrigation as a means of overcoming the summer drought period. In view of the short growing season and the fact that winters are too hard for the ideal pasture species, it is improbable that the temporary ley for grazing on the English model is applicable over a wide area of the northern countries; land cannot really be spared from the production of winter fodder for the long stall-feeding period. On the other hand, the growing season is frequently not much shorter than in Aberdeenshire.

Sources of Nitrogen The shortage of fertilizers gradually became evident during the war years in reduced yields of crops and milk. Nitrogen requirements can be met in various ways other than by fertilizers—through leguminous crops, indirectly through the grazing animal, through dung and urine from stables, or from compost. Much of the experimental work, particularly in Norway and Sweden, is concerned with the application of inorganic nitrogen at rates which appeared to be excessively high and uneconomic, resulting in the almost complete elimination of the clover in many cases. An important and cheap source of nitrogen is therefore not fully utilized.

Joensuu, Professor A. I. Virtanen's farm near Helsinki, is interesting in this respect. For fifteen years he has used no inorganic nitrogen at all and

the productivity of his land has greatly increased over the period. The rotation is: three-year timothy-red clover ley cut three times a year for silage (third year for grazing), potatoes, oats, spring wheat, ley. Professor Virtanen has calculated the nitrogen balance of this 84-acre farm for 1946:

	kg. N_2
Nitrogen fixed in all crops	2,780
Nitrogen in products sold from farm	570
Nitrogen provided in urine..	1,000
Nitrogen provided in solid manure	770

It is calculated that only 60 per cent of the nitrogen in the urine and 40 per cent in the solid manure has been used by the crops, i.e., a total of 900 kg. of nitrogen provided by solid manure and urine. Therefore, 1,880 kg. nitrogen must have been obtained from the soil. Assuming that the nitrogen content of the soil remains constant, an assumption which Professor Virtanen considers to be an understatement in view of his increasing yields, this quantity of 1,880 kg. must, he considers, have been provided on his farm by leguminous crops.

It can be seen from these figures that a large quantity of the total nitrogen in the crop is provided through dung and urine. Throughout the northern countries it appears that the importance of the grazing animal as a means of distributing this fertility, and as a direct or indirect means of controlling sward composition, is not yet fully realized.

Flax in Sweden It would appear that the war-time and pre-war extension of flax cultivation is likely to remain a permanent feature of the farming systems of Skåne, in southern Sweden. A special laboratory at Svalöf under the direction of Dr. Granhall is devoted to the breeding of special types and to the study of processing technique; in breeding, the basic types are Blenda (Swedish), Herkules (Russian), and a little Concurrent. There are said to be good prospects of growing high-quality flax in Sweden, although the country cannot compete in the production of low-quality fibre. Even with the high labour costs, Sweden hopes to be able to produce high-grade flax economically. The area of flax in Sweden has averaged about 11,000 acres during the past five years, producing enough fibre to meet 75 per cent of domestic requirements.

Trend of Farming In all four countries there seems to be an overemphasis on the dairy cow. The absence of herds for beef production is very noticeable and only in rare cases are any serious attempts being made to produce beef of high quality. Practically all the meat consists of the by-product of the dairy herd—veal and cow beef. Nor are there many sheep; even where small flocks are seen, they are usually regarded as producers more of wool than of meat.

ENGINE CARE

C. G. Bainbridge, M.I.Mech.E.
Barnstaple, N. Devon

THE most critical stage in an engine's life is the running-in period ; this may be taken to be not less than 20 hours of running and may extend from a few days to several weeks, according to the amount of use the engine gets. During this period it is important that lubrication and cooling are properly attended to, and that the loading and speed are kept well below the normal. Any trouble taken will be well repaid in the increased life and trouble-free service obtained from the engine afterwards—to say nothing of its increased second-hand value !

When an engine is new the bearings fit fairly tightly, and the engine is said to be " stiff " ; this is essential because however perfectly a surface is machined, it really consists of a series of minute ridges and hollows, and when two such surfaces rub together (for example, a shaft in a bearing) the highest spots on each cause the tightness or stiffness. If parts were assembled so that there was running clearance when the engine was new, there would soon be far too much clearance when the surfaces "bedded down"—that is, when the high spots were rubbed off.

Another reason for the careful handling of new engines is that when an engine runs some parts become hot while others remain comparatively cool, so that there may be some slight distortion which will increase the risk of some bearings becoming tighter than others.

Obviously, therefore, with tight bearings, overloading, excessive speed, overheating, or lack of lubrication during the initial stages of an engine's employment may break down the lubrication film or increase the tightness of some bearings so that they partially " seize," with the result that bearing surfaces may be ruined permanently.

Most manufacturers do a certain amount of " running-in," but time and cost do not allow this to be done completely, and it is up to the owner of the engine to cooperate with the manufacturers in seeing that the engine is handled carefully during its running-in period. Therefore keep the speed and power output below normal, and avoid heavy pulling at slow speeds, for 20 hours or so. It is equally important to avoid very slow running or " ticking-over," especially when starting up from cold, because at slow speeds oil is not forced through the oilways at sufficient pressure to feed tight bearings, nor is sufficient oil thrown on to the cylinder walls to ensure adequate lubrication.

The use of a light grade of good quality oil is desirable during the running-in period, and after eight to twelve hours running the oil in the sump should be changed. The reason for this is that a certain amount of foundry sand and metal particles may work out of the casting or joints or be forced through the oilways ; draining the oil removes this dirt and prevents it from becoming embedded into bearing surfaces or clogging oilways. The draining should be done immediately after a run—while the engine is hot and the oil very fluid, and when any dirt will be " in suspension " in the oil. Do not, on any account, wash out the sump with paraffin : refill with fresh oil.

Also, while the engine is hot, it is often a good plan to try the cylinder head nuts, and those on inlet and exhaust connections, for tightness. The expansion caused by the heat and the bedding down of joint materials will frequently slacken a joint slightly and, in such cases, it will be found that nuts can be tightened appreciably.

Lubrication Regular attention to lubrication arrangements is probably the most important single factor ensuring long life and freedom from breakdown or trouble of an engine. Unfortunately, as soon as fresh oil starts work in an engine, it becomes fouled in several ways which reduce its value as a lubricant. The following are the main causes of oil deterioration :

(1) Thinning or dilution by fuel which leaks past the piston (most frequent with paraffin engines, due to running them too cool).
(2) Contamination by gases escaping past the piston (especially with old engines) by carbon formed by the heat of the engine, and by dust taken in through the air intake or crankcase breather.
(3) Creation of sludge, due to water condensation in the crankcase, or by leaks from the cylinder liner or other water joint.

Dilution with fuel is, of course, worse with old engines than with new ones, due to worn cylinder bores and pistons. It is also more common with paraffin engines than with petrol, because of the greater difficulty of completely vaporizing and burning the fuel, especially if the engine is run too cool. Moreover, paraffin does not readily evaporate and remains longer in the oil as a " thinner," whereas petrol will gradually evaporate under the working heat of the engine. Fuel leakage may also be caused by unsuitable lubricating oil " gumming " the piston rings in their grooves, in which case there will also be loss of compression and power.

Apart from the troubles of old engines, dilution is caused by excessive choking of the engine when starting ; running on too rich a mixture ; not running a paraffin engine hot enough ; air strangler or choke partially closed, or choked air cleaner. A dribbling injector on an oil engine will allow unburnt fuel to pass into the crankcase.

Condensation of water inside the crankcase is greatest in cold weather ; this cannot be avoided, but on tractors the crankcase drain plug should be loosened daily for a few minutes in cold weather to drain off any water that may have accumulated. Incidentally, in exceptionally cold weather there is a danger that the water may freeze and block the pump strainer or oil pipes and thus stop the oil circulating.

The need for oil changes periodically should thus be obvious, and it should be equally clear that such changes are well worth the trouble and expense involved. Splash lubricated engines need more or less frequent oil changes according to the amount of work they do, as there is no way of removing impurities from the oil. Even engines fitted with oil cleaners need oil changes periodically, paraffin engines more frequently, and oil engines less frequently than petrol engines. Much will depend, of course, on the care and circumstances under which the engine is operated, and it is difficult to lay down precise rules.

The best time to drain is at the end of a run, when the oil flows freely and any dirt in the oil will be in suspension and so drain out with the oil. *Do not wash out the crankcase with paraffin* : generally, draining the oil when warm will be sufficient to ensure that the sump is clean.

Although most engine pistons are fitted with oil scraper rings, some oil will always be lost when running, due to leakage past the pistons into the combustion space, where it is burnt. The amount will be very small with new engines in good condition but will, of course, increase as the cylinders, pistons and rings become worn. Excessive oil consumption usually indicates worn cylinders or pistons, or defective piston rings—either stuck, broken or worn. When this happens an overhaul is indicated. Incidentally, the oil consumption with a new engine may be slightly higher than normal, until the piston rings " bed down".

With all lubrication systems, it is detrimental to the life of the engine to run with the oil below the correct level. The effect is to starve the bearings of oil, and the deterioration of the oil will be more rapid because of the small quantity in circulation. On the other hand, over-lubrication is equally wrong, as it is wasteful and results in a " dirty " engine, with consequent loss of efficiency and power.

A pressure gauge—if fitted—is merely a visible indication that oil is being circulated ; a separate check on the level must be made. If the pressure indicated is very low, or there is no pressure at all, the cause should be investigated ; it may be a broken or choked oil pipe or pump strainer. On a tractor the crankcase may have been holed by striking an obstruction.

The pressure will always be slightly higher for a short period after starting from cold, falling to normal when the engine is warm and the oil flowing freely. On the other hand, an abnormally high pressure may indicate a blocked oil pipe or passage, or a choked oil cleaner. In short, stop the engine and investigate any abnormal pressure indicated.

The use of the correct grade of oil is an important contribution to the easy starting of an engine. Do not, therefore, use a heavier grade than that recommended.

Very often the use of different grades is recommended for summer and winter. The reason for this is that during cold weather the oil should be of a lighter or thinner grade than that used during warm weather. Oils suitable for petrol engines are not, generally speaking, suitable for diesels, for which special oils are recommended.

Routine Maintenance The oil level should be inspected and, if necessary, topped up to the correct level with fresh oil at the beginning of each run ; with tractors, the dip-stick reading will be reliable only if the tractor is standing level. Do not inspect the oil level or refill with fresh oil while the engine is running.

Filter elements need attention from time to time ; many cleaners are fitted with a by-pass allowing oil to pass direct from the pump to the bearings if the filter element becomes choked. But when this happens the oil is not being cleaned, and the wear and tear on the engine increases in consequence. Some idea of the amount of dirt removed from a typical tractor lubrication system may be gained from the fact that in one particular instance a cleaner element weighed 1½ lb. after 300 working hours, compared with ½ lb. when it was new.

Some elements may be removed and washed in petrol and then replaced ; others are provided with a cartridge of filter material which must be discarded and replaced with a new one periodically ; the makers' recommendations should, however, be followed as to changing periods. The pump strainer in the crankcase does not need frequent attention, but it should be cleaned at every overhaul.

Storage of Diesel Fuel The trouble-free operation of a diesel engine necessitates a supply of clean fuel ; any possibility of water, dust, or foreign matter of any sort getting into the fuel storage tanks, handling receptacles or engine service tank, must be avoided at all cost, otherwise the fuel pump and injectors will suffer.

When the consumption is comparatively small, the 40-gallon delivery drum may be sufficient for a considerable running period : in such cases careful handling and storage of the drum is essential. It should be supported on a trestle or stool, under cover, so that the outlet end is slightly higher than the opposite end ; the outlet should be fitted with a tap. The

drum should be allowed to stand for a day before oil is drawn off in order to allow any dirt to settle ; it is in fact a good plan to arrange the drum rack to take two drums and always have a full drum in position before the service from it is exhausted. The first draw-off of oil through the tap should be discarded in case any dirt has been washed through the tap.

The drum should not be tilted towards the tap in order to draw off the last drop of oil : it is better to waste the oil remaining in the drum below tap level than to risk stirring up any sediment that it may contain.

The containers used to convey the oil from the storage drum to the engine service tank should be cleaned scrupulously with a non-fluffy rag before and after use, and stored in a clean cupboard.

When the fuel consumption necessitates the installation of a storage tank, the size of the tank should enable the fuel to be delivered in ample quantities at infrequent intervals. Welded, ungalvanized tanks are most satisfactory and they should be installed above ground, if possible under cover. The tank should be set on a slight slope—the outlet 3 or 4 inches above the bottom of the higher end, and a drain cock should be fitted on the under side of the lower end.

The filling connection must be on the top of the tank, and the hose connection screw thread should be 2½ inches gas, or otherwise arranged to suit the oil suppliers' delivery pipe. A dust cap with a similar thread must be attached to the connection neck by a chain. The tank should also be fitted with a manhole for cleaning purposes, also a vent pipe of the same diameter as the filling pipe ; the vent pipe outlet should be directed downwards and protected by a wire cage.

Every precaution should, of course, be taken to ensure that the inside of the tank is thoroughly clean before it is filled for the first time, and always any accumulated water and sediment should be drained off, before filling, otherwise it will be stirred up by the fresh charge.

When the tank has been freshly filled at least a day should elapse before oil is drawn off, in order to allow any dirt to settle : it is therefore a good plan to arrange for the service tank to be full before the storage tank is filled.

THE FORAGING BEHAVIOUR OF HONEY BEES

C. R. Ribbands, M.A. (Cantab.)
Rothamsted Experimental Station, Harpenden, Herts

THE foraging behaviour of honey bees is a matter of great importance to agriculture, because they pollinate many of our fruit and seed crops. Farmers will therefore be interested in recent experiments which suggest the possibility that honey bees can be trained to visit and pollinate crops which they might otherwise ignore. These experiments were made by Professor Karl von Frisch of Munich University. His detailed studies of the capacity of the honey bee to distinguish colours and patterns have contributed a great deal to our knowledge of honey bee behaviour during the past twenty-five years, and he has now turned his attention to studying some of the methods by which honey bees can communicate with each other concerning their food plants.

If a dish of scented syrup is placed near a hive it may remain unnoticed for days, but once the dish has been found other bees soon come to it, until it is covered with bees, which also search for and find any other similarly filled dishes in the vicinity. The newcomers do not follow the original finder to the dish, but find it independently. How then, do so many follow so quickly after the original discoverer ?

Round Dance Von Frisch kept his bees in an observation hive—a hive made with glass walls, through which the behaviour of the bees could be observed while they were upon their combs. He placed dishes of syrup near the hives, and marked bees which visited them with small blobs of coloured paints, so that he was able to distinguish them from other bees when they returned to their hive. He found that when they returned to the combs they gave sips of the syrup they had collected to other bees around them, and then began to turn round and round in small circles, alternately clockwise and anti-clockwise. This excited the bees to whom they had given part of their load, and induced them to follow the pioneers. A series of experiments established that this Round Dance, as it was called, was the means by which the other bees learned of the existence and the whereabouts of the new and desirable food source.

A dish containing phlox flowers and sugar water and a bowl containing phlox and cyclamen flowers were then placed near the hive. When the sugar water had been found other bees from the hive flew to the bowl of phlox and cyclamen flowers, and searched the phlox flowers but ignored the cyclamen. When the experiment was repeated on another occasion, but using cyclamen instead of phlox in the sugar syrup, the bees then searched the cyclamen in the bowl and ignored the phlox. Further experiments proved that the bees within the hive learned the scent of the desirable food source in two ways—either from the scent within the nectar which they had imbibed from the successful forager, or by smelling the scent adhering to the foragers' body. It was found that the former was the more important method, because the scent of the food source did not adhere very satisfactorily to the body of the forager if she had to fly a long distance back to the hive.

Von Frisch strikingly demonstrated the effectiveness of the scent perception of bees and of his own ability to train them by taking them to a botanic garden. There, in the midst of 700 different kinds of flowers, including many of their favourite nectar sources, he was able to train bees to find a clump of blossoms of the everlasting flower, *Helichrysum*, which they do not normally visit, by feeding other bees from the same hive upon plucked *Helichrysum* covered with syrup.

Wagtail Dance While Von Frisch was conducting experiments with his syrup-fed bees, he noticed that other bees were returning to the hive carrying pollen loads, and that these bees were performing a rather different dance, which he called the Wagtail Dance. The Wagtail dancers were describing a figure-of-eight upon the combs, and wagging their "tails" vigorously, especially while they were running through the central portion of the figure, and as this performance was noticeably different from the Round Dance of the syrup-gatherers, Von Frisch concluded that pollen gathering was associated with a different dance from nectar gathering.

These results were published more than twenty years ago, and were well known to scientists and beekeepers, but they did not attract any unusual attention because the dances had frequently been observed and the interpretation of them given by Von Frisch seemed likely and in accord with expectation. In the past few years, however, von Frisch has been conducting more elaborate experiments, with results which are more startling.

He started to feed syrup in dishes several hundred yards away from his observation hive, instead of in its vicinity, and was surprised to find that marked bees from these dishes performed the Wagtail Dance instead of the expected Round Dance. Then, of course, he started to mark bees feeding upon syrup at various distances, and he was able to show that the shape of the dance gradually changed, and that the Round Dance and the Wagtail Dance were just different versions of the same dance. As the food source of the Wagtail dancers was brought nearer to the hive, the two circles of the figure-of-eight came closer together, until between 100 yards and 50 yards from the hive they overlapped more and more, and finally overlapped completely to produce the Round Dance which he had previously seen. Thus he proved that the configuration of the dance was a measure of the distance of the food source from the hive, and that this was a means by which bees might communicate this important factor from one to another. His previous misinterpretation had occurred because syrup had been fed close to the hive, and all the food pollen sources had been at some distance from it.

Von Frisch also showed that the vigour and persistence of the dancing varied with the ease of obtaining the load, and that the dancing was discontinued altogether if the syrup concentration was weakened sufficiently.

Further Observations The next experiment was to feed nine marked bees on thyme-scented sugar at a dish 300 yards north of the hive, while maintaining watch on a circle of similar dishes also situated 300 yards away from the hive, in other directions, and on dishes close to the hive. Many new bees arrived at the dish 300 yards north of the hive, and at dishes close to this one, but none visited either the dishes close to the hive or those in other directions. A similar result was obtained when the experiment was repeated with the original dish in a different direction. This work indicated that bees could communicate both distance and direction, but how did the latter occur ? Von Frisch's careful observations at his hive again supplied the answer. In observations on a vertical comb he found that the angle of the figure-of-eight on the combs varied ; when the food source was in the same direction as the sun the central portion of the figure-of-eight (which he called the " tailwag run " because tail-wagging was then most vigorous) was vertical, but if the feeding place remained constant the angle which this tailwag run bore to the vertical changed as the day wore on—through the same angle as the sun, but in the opposite direction. This then, was the mechanism through which the bees could communicate direction to one another. Moreover, the direction was correctly indicated by the angle of the dance even if the sun was completely obscured by cloud.

To sum up, Von Frisch's experiments have demonstrated a means by which bees can direct others by communicating the scent of the food source, its quality and abundance, and its distance and direction. Other scientists will certainly wish to repeat and confirm such important discoveries, and it is possible that when this has been done Von Frisch's story may be modified in some details, but the main outlines appear to have been firmly sketched by his careful experiments.

Value to the Farmer How can all this knowledge, interesting though it is, become of any use to the farmer in his striving for better crops ? Let us first consider its practical application in horticultural practice, where results are more easily achieved and assessed.

In the absence of costly measures, such as hand pollination, a number of crops grown under glass have frequently failed. In such cases if a small colony of bees is confined in the greenhouse with the plants to be pollinated, and the bees are fed with syrup scented with the blossoms of this flower, those bees which find the syrup will feed it to others, dance vigorously, and induce the others to fly out and search the blossoms of the plant in a vain attempt to find the syrup, and in the process to pollinate it. The method can be applied to pollinate most kinds of flowers, whether they are normally visited by bees or not, provided either that they have a scent detectable by the bees, or are sprayed with the scent to which the bees are being trained. It has been applied successfully to crops as diverse as schizanthus and tomato.

In agricultural practice the difficulties are greater, but perhaps the possibilities are also greater. There are many seed crops which require insect pollination before seed can be set, and crop failures can sometimes be attributed to lack of adequate pollination. Red clover, lucerne, flax, linseed and various brassicas come into this category.

Red Clover Pollination In Britain the most important crop of this type is red clover, of which very substantial acreages are grown for seed every year. Red clover flowers secrete their nectar at the base of their corolla tube, and unfortunately this tube is longer than the tongue of the honey bee, which therefore can reach the nectar only on exceptionally favourable occasions, when so much nectar has been secreted that it has partially filled the corolla tube. But once the bee's tongue tip can reach the nectar of a flower the whole supply can be sucked up.

Red clover blossoms therefore become very attractive to honey bees whenever and wherever the season or the locality is such that the red clover provides a strong nectar flow, so that the nectar rises to a high level in the tubes. At other times honey bees can work this crop only for pollen, and therefore most of them forage elsewhere and leave the red clover crop to the long-tongued bumble bees, which can reach the nectar. Agricultural practice unfortunately tends to lower the proportion of bumble bees to red clover both by eradication of nesting sites suitable for bumble bees and by growing the red clover in large blocks, and so pollination is usually inadequate unless honey bees as well as bumble bees work the crop.

From the bee's point of view the red clover crop is a borderline case. Some bees nearly always work it for pollen, but the proportion of foragers upon it in poor seasons will depend upon the availability of other forage—sainfoin, white clover, etc.—in the vicinity at the same time. Is it then, possible to tip the balance in favour of the red clover crop ?

Russian scientists claim to have obtained success in their attempts, and Von Frisch himself has published details of successful experiments in this

respect. It is necessary to feed the bees with the clover-scented syrup every morning during blossom time, or the crop is soon deserted. Von Frisch used a heavy concentration of bees—two colonies per acre—and fed each colony with about 4 oz. of clover-scented syrup each day. For comparison he used control fields supplied with similar numbers of bees, and fed the same amount of *unscented* syrup. He claimed that bees were three to four times as numerous on the experimental crops as on the control fields, and that in nine experiments the average increase in the seed yield was 40 per cent. He also found that results were more successful if the scented syrup was fed to the bees from dishes on the crop instead of in the hive, a result which his earlier work on the communication of distance and direction would have led one to expect.

In 1947 trials of this method were organized by Rothamsted Experimental Station in conjunction with the National Agricultural Advisory Service, and carried out in Essex and Suffolk. Unfortunately 1947 proved to be an exceptional year in which the fine, dry weather induced a bumper nectar flow in red clover, and honey bees flocked to the crop everywhere without waiting for training. In these circumstances no valuable results were obtained, but it is still believed that the method might prove very useful in normal and bad years, when the bees would tend to ignore the crop unless they were trained to go to it. In that case it will provide another addition to the long list of instances in which scientific experiments, originally conducted in pursuit of knowledge for its own sake, have found a practical application.

AUSTRALIAN TOUR

John Green

It is a year now since I completed my fifteen month journey through rural Australia. Distance of time and space has lent no further enchantment to the strange fascination of the Australian Bush, although it may have matured my own judgment. While I was in Australia I saw all the main temperate and sub-tropical regions, and was fortunate in some districts to revisit them throughout the seasons. All the time I tried to enter into the Australian agricultural problem, and to forget the British. I found it a great education, because only where the conventions of farming do not apply does the universal truth of first principles become really apparent. There is intellectual stimulation in watching the reaction of farmers of European stock to entirely new environments. You appreciate how slowly the prejudices of the Northern hemisphere get worn down by the unfamiliar climates of the Antipodes. It is of particular interest to see mechanized agriculture introduced to a range of farming conditions (even rice growing) so different from those for which the techniques themselves were invented. Furthermore, what is true of the adaptation of the European and his techniques is still truer of the adaptation of his livestock.

After I had been in Australia about two months, I understood little about its agriculture. It remained a mystery how the great wealth of wool

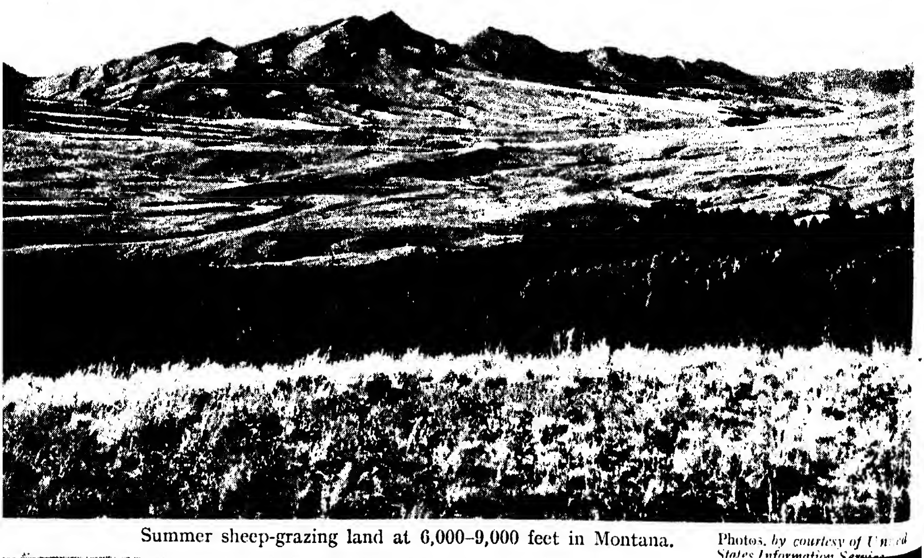
and wheat and dairy produce matured under what appeared as constant drought conditions. In an arid period in Britain our grazing may be worthless, but in Australia the only factor that seems to limit the stockman is a clean water supply. Cattle and sheep maintain themselves on dry food, particularly what they obtain from the shed seeds of subterranean clover. It is important not to overlook the value of dryness and warmth, which cuts down the amount of food that stock require for maintenance. The absence of stabling and other farm buildings is also an obvious asset. It is one reason why horses are cheap to keep and are still used more in Australia than in any other farming country of the New World.

It is natural that a continent the size of Australia should contain drought areas and that flat country exposed to extensive land and ocean masses should have wide fluctuations of climate. However, these are not entirely unpredictable. There is a certain statistical rhythm, even if it does not conform to the twelve monthly cycle which we know in Europe. In the past the Australian climate may have been blamed unduly, on the one hand by the pastoralist who overstocked, and on the other by the farmer who failed to conserve fodder. Reserves of capital and strict agricultural economy were doubly incumbent on the early Australian settler, and the fact that he tended to speculate both on the seasonal and topographical chances of his country was perhaps a relic of his European impatience. At any rate, Australia is not a country without rain, but one in which rainfall and evaporation are too evenly balanced. In the central latitudes, the influence of the monsoon makes the rainfall variable. The fringes of the wheat belts and magnificent soils of south-east Queensland still tempt the unwary. However, throughout the Mediterranean belt, particularly in Gippsland, western Victoria, south-east South Australia, and Western Australia, the climate is as stable as in Britain. There you merely substitute the annual summer drought with grass fires for the winter frosts in Britain. (There is little doubt that the latter is the more expensive to the farmer.) Where fodder conservation is practised for the summer months as systematically as haymaking for our northern winters, these districts are safe. Moreover, Australia has already made tremendous contributions to world agriculture by the introduction of subterranean clover. She has brought under control wide areas of the world's surface formerly uninhabitable. Soon, by experimenting with peanuts, maize and grain sorghums, she may also bring stability to the sub-tropical districts of south-eastern Queensland. All this has entailed a conception of closer settlement or mixed farming that was strange to the early pioneer or frustrated gold-digger. The undying glory of these men was that they cleared the forest by hand in days when bulldozers were unknown. Though the Australian climate, like many Australian horses and some Australian people, still fights wildly for its head, I am convinced that the mixed farmer will triumph over an increasing area. He will become master of more of his continent as scientific knowledge of its idiosyncrasies is amassed.

I would like to refer to one or two individual aspects of Australian farming.

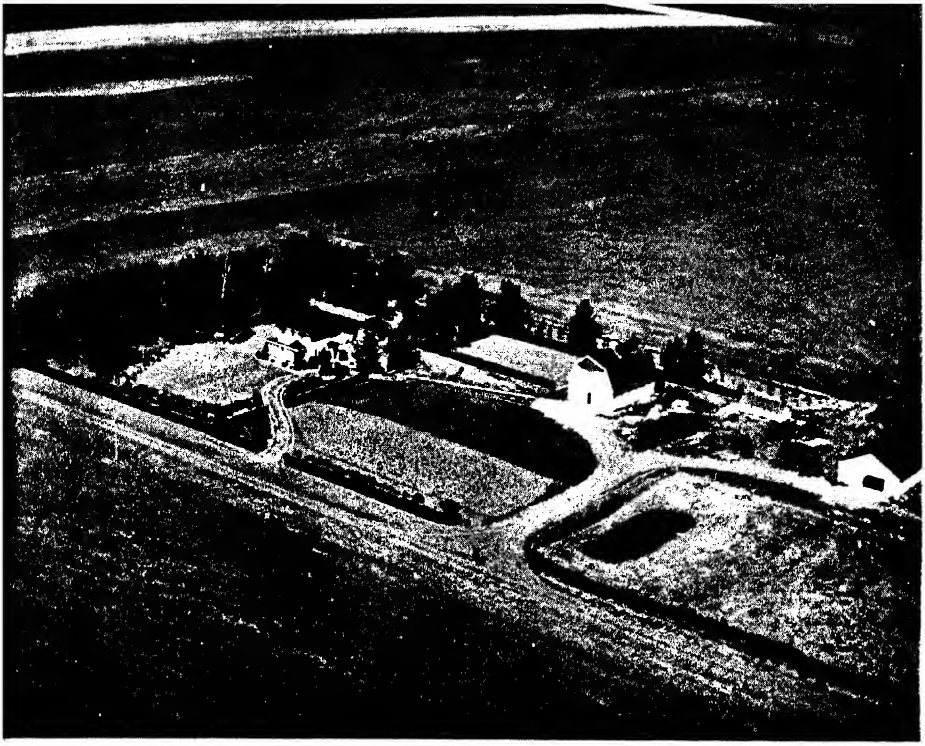
Milk I believe Australia is a record-breaking country for the dairy cow. However, she must first be acclimatized and properly handled. I consider that the low standard in production at the present time is due largely to snobbery. The cow has never had the same pride and capital behind her as the Merino sheep. Often I think the cow has found herself in the possession of men who believe that the production of rich grass alone will do all that is necessary. Australia is certainly not short of protein from sources other than grass, and wherever the water level allows lucerne to be

Typical, well-run farm in New Jersey, deriving its main income from the sale of milk from 40 pure-bred Holsteins. Poultry and pigs are a sideline.



Summer sheep-grazing land at 6,000–9,000 feet in Montana.

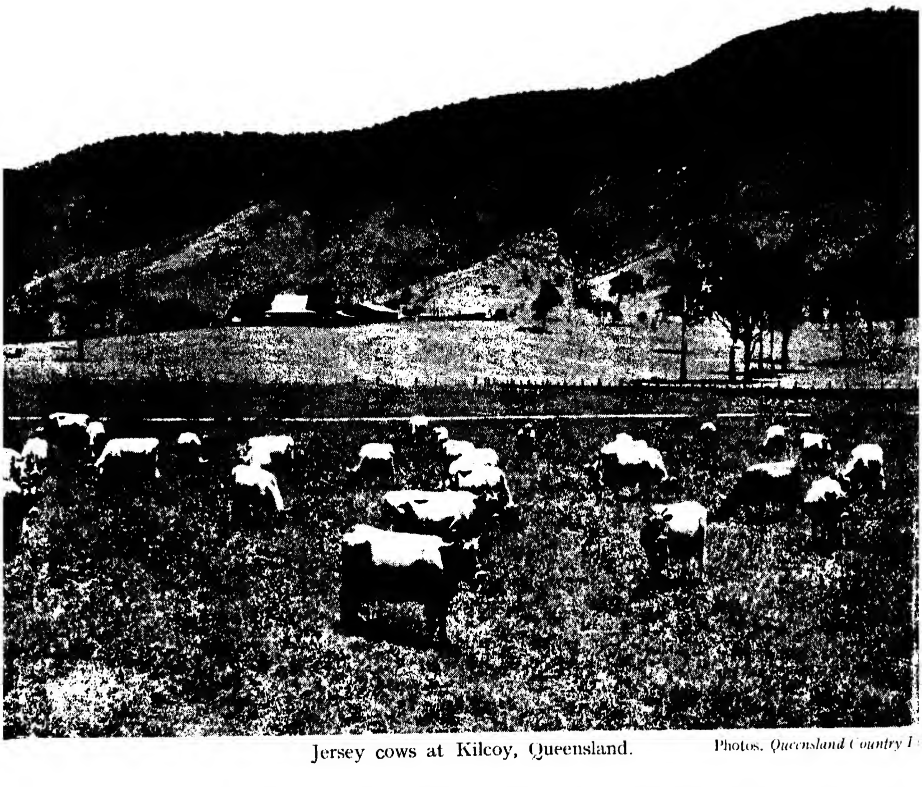
Photos, by courtesy of United States Information Service



District farm in Saskatchewan. Note windbreak around buildings. Photo, *National Film Board*

Typical dairy farm in Ontario. Photo, *by courtesy of Agricultural*

Polled Hereford heifers at Boggabilla, New South Wales.



Jersey cows at Kilcoy, Queensland. Photos. *Queensland Country L*

adequately cultivated, fine milk records have been achieved. I used to console the Australians by telling them that the best milk in Britain was now produced from sugar beet and not grass. The moral was not lost on them. It was following this remark in a broadcast that I made the acquaintance of the head stockman who had cared for Melba XV during her world-beating lactation of 32,500 lb. at 5 per cent butter fat, and who managed again in 1939 to average 17,000 lb. at 4.3 per cent butter fat with eight cows in the Australian Illawara Shorthorn Society's lactation competition. Australia is the last country left in the world where Shorthorn cattle largely of Durham origin still dominate the dairy industry. The Jersey is the next most popular breed. The Friesians and Ayrshires to be found in areas of town supply are not outstanding. There is no doubt that insufficient new blood has been introduced into all dairy herds in Australia, although this is now being remedied.

Meat : WOOL, MUTTON AND LAMB

In the case of sheep it is impossible to consider any aspect of agriculture without regard to Merino wool, which is still the main source of Australia's wealth. The sparsely scattered fleeces throughout the vast interior become an aggregate of some hundred million pounds sterling and the bulk of the world's eventual supply of animal fibre. The prestige of the inland sheep station thus remains, despite the incidence of taxation. However, the branch of the industry which now interests farmers in the districts of closer settlement is the production of lamb as a development from this staple commodity. Australia cannot hope to produce lamb as cheaply as New Zealand, but this can adjust itself in the relative values of land. The point is that mutton is a natural by-product of wool and a source of revenue in districts which are more favoured than the pastoral areas.

An obvious weakness in the fat lamb position in Australia has been the lack of geographical order in the situation of breeds. Breeds tend to exist haphazard throughout the farming areas without sufficient regard to topography and farming practice. There are no great markets such as in the Border districts of Scotland, where you know exactly the quantity and quality of store sheep that will be pitched at a given time of year. The border regions start with an initial endowment of the scraggy Merino ewe, which is the " hefted " pastoral sheep similar to the Cheviot or Blackface in Scotland. The various scientific establishments seem at last to have agreed on the method of grading it up to a profitable form of mutton. Their opinion favours a first cross with an English Longwool, preferably the Border Leicester. This retains character in the medium grade wools which is generally superior to wool of a dual-purpose type such as the Corriedale. The final stage is to produce the fat lamb with a cross of the Southdown or Dorset Horn. In the southern parts of Australia the Southdown is favoured as producing a high quality carcass of 32 lb. at weaning. Nevertheless, the Dorset Horn is likely to make the most progress, particularly in New South Wales and south-east Queensland, on account of its natural affinity to the Merino, its supremely early maturity and capacity to withstand a hot, dry summer. From the breed point of view the Australian, with his long tradition of wool, is prejudiced against any blackfaced breed and also dislikes wool near the eyes.

The position in regard to beef and mutton is tied up with the general demand for meat on the Australian home market. No country can set indefinitely an export standard which bears no relation to its home demand. The feed-lots of Iowa and the bullock yards of Norfolk have in the past owed their existence to the hotels and restaurants of Chicago and London respectively. In this respect, Australia with two cities having more than a

million people is in a better position than New Zealand to develop a local demand for meat. However, the consumer in Australia still has an uncultivated taste for beef and mutton. The Australian public has never educated itself to demand grade and the Government has therefore remained undisposed to pay for it. The well-known tendency in the case of cattle and sheep has been to overland from the pastoral areas straight to the coastal abattoirs. These journeys provide more material for the author and film producer, than they do for the plate of the fastidious consumer. They have become an anachronism from the farming point of view because the stable farming districts exist for the most part on the high escarpment which divides the pastoral interior from the coastal plain. Here meat might be suitably finished if the abattoirs were moved back from the coast and refrigerated transport improved. There is no doubt that the tendency in the past has been for the abattoir to serve the interests of the packer and exporter rather than the land.

BEEF The principal beef breed of Australia is the Shorthorn with the Hereford an immediate second. The Shorthorn and Hereford seem to have acquired a wide distribution, particularly in the North Territory and Queensland. It would appear that these breeds were formerly considered a guarantee of export quality, but since quality can have no meaning for cattle that have " overlanded " a drought-stricken continent, and there is no evidence of any superior adaptation to tropical conditions, it seems reasonable to believe that Asiatic cattle might have done equally well. Experiments with the Zebu cross are being tried in Queensland at the present time. In the settled farming areas the Aberdeen Angus is making the most rapid progress of any breed at the moment. It seems too that the Shorthorn and Hereford will be hard put to resist this challenge or that of the polled breeds of the United States. Polled cattle are accepted without dispute in Australia today, and anyone who has handled a thousand head of cattle for any purpose whatsoever can understand the reason. The Red Poll has not made progress but is a popular station cow for milk and slaughter, while the Devon is popular in dingo country because the female is regarded as the most protective of her calf.

Water If in Britain we have spent a thousand years taking water out of our soils, the Australian may take confidence from the fact that he has only spent a century putting it back on to the land. There is little to choose in uselessness between a bog and a desert. This is especially poignant to Australia because the unleached and unlimited soils of the continent are good (often far better than New Zealand). Moreover, the extreme age of the land eroded through centuries has left few natural contours suitable for impounding water. The already extensive achievements in irrigation are largely confined to the Murray River and its tributaries, which alone carry snow water from the limited Australian Alps. Irrigation, too, has its own problems which the tremendous will and enthusiasm of the irrigation farmer (equally marked in California and Palestine) is tending to overcome. (In the Murrumbidgee Settlement I encountered the unique practice of farmers buying broadcasting time to improve their knowledge of these new problems.) However, if the capital costs of irrigation in farming are heavy the returns are also considerable. It is the same whether these come from orcharding under citrus and dried fruit, or mixed farming with a basis of lucerne. Where Australia has still scope for development is in control of her erratic Northern rivers in New South Wales and Queensland. Quite apart from the daydream of ever turning them into the interior, great opportunities still exist for impounding summer rains and sprinkler irrigation from artesian sources.

The war in the Pacific awakened the eastern states to a new consciousness, and their further development depends on the white settlers' success in bringing sub-tropical soils under technological control. In this kind of farming the mature and experienced leaders of Australian agriculture have already blazed the trail for pioneers in other lands, including Africa.

The Needs for the Future Finally, I would like to mention the drawbacks to Australian rural development. The first is housing. It is an irony that there should be acute housing shortage having regard to the climate of Australia and the plentiful supplies of timber which make housing relatively cheaper there than elsewhere in the world. The second is the cost of mechanization which still checks the advances in agriculture that have been made under similar conditions in the United States. Here again, steel in Australia is cheap, and the standard of agricultural engineering as high as that of any other secondary industry in the Dominion. Finally, the education of the farmer is not as far advanced as in Britain, Canada, New Zealand or South Africa. Despite the immense wealth that Australia has already taken out of the land, her educational and research endowments are very limited and leave much leeway to be made up by the Federal and State authorities.

To enlarge the rural mind, to provide tools to its hands and above all to create a more kindly environment in the Bush, stands between success and failure in releasing the primary wealth of the Australian Commonwealth. The pastoral age is closing and the dawn of mixed farming, under conditions strange to men of European habit, is causing its perplexities. But periods of transition are always dangerous. A few years of depression, with the Bush lying under a relentless sun, and demoralization could set in which could create a rural slum. Sydney and Melbourne, already selfish and avaricious, might be left like Tyre and Nineveh, desolate. Nor would British or American capital bring help to a land that was hopeless and unpopulated. Rural Australia is still a great challenge to the white man. It is a challenge farther in distance than, but just as near in sympathy as, Africa. It calls for total lease-lend of experience and capital goods between those who carry hay in mud and rain and those who plough the dust in sunshine.

SIX MONTHS' IMPRESSION OF FARMING IN CANADA AND THE U.S.A.

DONALD STOKES
Ellesmere, Shropshire

SIX months' visit to Canada and the U.S.A. gave me a great opportunity of studying at close hand the problems with which farmers in those countries are faced and the solutions which so far they have found to them.

For three months I worked on U.S. and Canadian farms ; for the other three I visited research and experimental stations and farms in company with "county agents," who act as agricultural advisers.

Everywhere I was impressed by the way the American and Canadian farmers and farm workers alike are doing their job. They are keen and

Smooth brome grass is an extremely productive grass for hay and silage and supplies a great deal of bulk. It has a very high protein content up to maturity (9.9 per cent crude protein). Timothy hay is 6.2 per cent crude protein.

The technique of haymaking is very similar to British methods, with the exception that the American farmer puts in the turner sooner than is general over here. Pick-up balers are becoming very popular. Bale weights range from 50 to 90 lb. Contractors charge around 6d. per bale, and in some parts of the country this figure includes direct loading on to a trailer. Barn drying of hay is becoming increasingly popular; hay is placed in the enclosed barn and air carried by wooden ducts is blown through. Experiments, already attended by promising results, are being carried out with baled hay erected to form tunnels, air being blown through these tunnels to aid drying.

"Cold" Silage It is in the sphere of silage-making that methods and technique differ widely from our own. More and more farmers are turning to grass silage as an easy, cheap, and reliable way of supplying roughage. The partial failure in 1947 of maize for silage, due to the wet spring and summer drought, will strengthen this tendency, but it is primarily due to soil erosion and labour shortage that farmers are changing to grass silage.

Silage-making by the wilting method is now widely adopted, the following conditions being necessary:

(1) Silos should be airtight and have smooth walls.

(2) The crop should be allowed to wilt slightly, and loads put in the silo with a moisture content of not less than 60 per cent and not more than 68 per cent. Odd loads of 70 per cent or down to 55 per cent have no detrimental effect if kept away from the top of the silo. With trench silos, none of the crop should have a moisture content of less than 60 per cent.

A slightly wilted crop when ready for the silo appears a little lighter in colour, and the leaves and stems will be limp but not dry or curled. Twisting will bring moisture to the surface of the stems but no free moisture will run off. Upon rubbing the *chopped* crop, the bruised stems and leaves will feel cool and moist but not wet.

(3) The cutter-blower should be set for ¼-inch cut for close packing.

(4) Distribute the material evenly and trample thoroughly in the top third of the silo.

(5) Put 4½ feet of heavy unwilted material on the top, level off and keep well trampled near the wall while settling.

It will be noticed that there is no temperature control (it is unheard of in the U.S.) and no reference to a slow rate of filling. In fact a 100 tons or more per day can be ensiled by this method. Latest machines like the "forage harvesters" are capable of picking up, chopping and blowing into a trailer or lorry 10-12 tons per hour.

To avoid spoilage, silos are filled so that the material is kept level to prevent moisture seeping to the outside. This also agrees with my own, British experience.

Grass Drying Wilting is also practised for grass drying. Experiments show that to obtain 1 ton of dried material from unwilted grass (74.5 per cent moisture), 176 minutes were required, fuel oil consumption 64.8 gallons. Wilted grass (59.5 per cent moisture) took 87 minutes per ton of dried material, fuel oil consumption 31.6 gallons.

Grass drying is a specialized industry; it is seldom undertaken by individual farmers, unless on a cooperative basis. High temperature rotary driers are the most popular. Dried grass is sold on its protein analysis—

15, 17 and 20 per cent material, and the price is 20 per cent below that of dairy concentrates.

The Small Farmer and Increased Production The basis of U.S. and Canadian farming is the family farm, the vast majority of them being owner-operated. In the past the soil has been greatly exploited in the cause of cheap food, and soil erosion is still a serious problem ; but the younger farming generation is becoming soil conscious. More and more farmers are now college trained and very much alive to the dangers of soil erosion. I do not believe that ultra cheap food will ever be produced again at the cost of soil exploitation, but I do believe that because of improved education and farming methods and re-equipment with high output labour-saving machines, the U.S.A. and Canada will continue to increase their food production for many years to come.

We British farmers should take a leaf out of the book of our Canadian and American friends and do everything in our power to re-equip and modernize our own farms

THE COMMON TOAD

F. Howard Lancum, M.B.E., F.L.S.
Ministry of Agriculture and Fisheries

IT is unfortunate that so little has been written about the common toad—ugly, likeable, maligned and maltreated *Bufo vulgaris*. Worth its weight in gold to any gardener, for centuries the toad has heaped upon us coals of fire, conferring upon us many benefits that we have ill deserved. If the toad could think it out, probably it would have wearied of well-doing long ago.

In olden days the unlucky toad's chief claim to fame was that it was one of the most potent ingredients in the hell-broth of the witches of the period, and many a pinchbeck wizard, who would have benefited by a course of stone-breaking in a gaol, got an easier living by dabbling in toad "magic" to the detriment, mental, physical and pecuniary, of the community at large.

It is to our discredit that some of the toad's old-time reputation still sticks to it, that it is regarded with horror or aversion where it should be respected and cherished as the good friend of man that it really is. Even today, modern education notwithstanding, there are people who seriously believe that the toad spits fire, poison or disease, or even all three !

Let us face one fact—the toad is really an ugly creature. It is a cold, clammy, warty and generally "pudgy" animal that most people hate to touch. That is bad luck for the toad. But even in its physical ugliness there is one great redeeming feature, for, to my mind, few things in all creation are more beautiful than the toad's black, lustrous, gold-rimmed eye.

Long ago we had in our garden, for three successive summers, a fat, aldermanic toad whom for some reason I do not now remember we called "Theophilus". We built for him a house of four bricks in a corner of the garden, in which he lived by day, all the summer after hibernation and settling his family affairs. His reputation was local but immense. Every

youngster in the village and most of the grown-ups knew him, and when, in the fourth summer, he failed to return to his house of bricks, his presumed demise was lamented by a large circle of friends and acquaintances.

It was from Theophilus that I learned many things about the ways of toads. Through him I discovered why it was that although toads in general periodically shed their skins and come out in fine new ones, hardly ever could I find a toad's discarded coat. Theophilus ate his ! To the shedding of a toad's coat there goes much striving on the part of the toad itself. First the skin splits down the back, and after a while it begins to curl at the edges ; but if the affair is not going as well as it might, the toad reaches round and with its fingers helps on the good work. When I saw Theophilus shedding his skin he seemed fussed with the impatience of a fat man uncomfortably involved with a too tight jersey that he wished to get out of as quickly as possible.

From Theophilus, too, I learned that toads showed little interest in edible living things unless they moved. Often, at dusk, I saw him regarding an offering of ours with the intentness of an old gentleman who has doubts about the quality of a club cutlet. If the thing was dead or motionless, Theophilus remained unconcerned, but if it moved at all and it was the sort of thing he fancied, he had it in no time. Also, with his tongue he could catch flies and moths with the speed and certainty of a chameleon. As for snails ; I have seen him stuff himself with them—meat, shell and all—until he literally bulged ; but never did I see him touch a slug. He needed only a liking for slugs to make him the perfect gardener's friend, and in truth he was very nearly that as it was.

Some of the ways of toads are beyond my understanding. In my garden one summer night I came upon a fat, aspiring toad which, on that night and several more, strove earnestly but unavailingly to climb a stone wall about 5 feet high. Night after night I watched, hoping that I might discover just why that Don Quixote of a toad tilted so vainly at a smooth stone wall. If it wished to escape from the garden (which I doubt) there were other and much easier ways of doing it. Toads are quite good climbers, but except for the lowest part of it that wall was beyond the climbing ability of any British toad. At times I helped this one to what I imagined must be its goal by lifting it up and putting it on top of the wall, but as it always tumbled down again on the same side from which it started, neither of us was the better for it. Indeed the toad might have been the worse had I not cushioned its falls with a folded sack. I still do not know what that toad was after.

I think that a toad eating a large worm is one of the funniest sights on earth. Usually it grabs the worm by the middle, and finding itself at once in difficulty with some inches of wriggling worm on either side of its jaws, with splayed fingers stuffs the loose ends into its mouth, like a greedy child with its first banana. At times I have been tempted to believe that in the face of a toad so engaged I have detected a hint of self-consciousness !

When I was a boy I had a friend of my own age, who had different views as to the most interesting forms of natural life and who chose to be an entomologist. Often he would go out at night, "sugaring" for moths. He would paint a broad stripe of some sweet mixture on the trunk of a tree, and go round later with a lantern to see what moths he had lured. The sugary stuff had a kick in it in the form of a few drops of rum, and any moth partaking too well eventually lost the use of its faculties. One night, while looking at his sugared tree, my friend saw something shining on the ground below, and turning down the beam of his lantern he found a little company of expectant toads, waiting for such moths as became tipsy and fell helpless

to the ground. There were four of the toads, and all of them were doing well.

There is one particular toad riddle to which I have never found the answer; nor have I yet found anybody who can help me. In the spring, toads come out of their winter sleeping quarters and go to water in which to spawn. All the toads of a district will take part in this annual pilgrimage. I do not know how wide their boundaries may be, what separates one area from another, how many toads go to any one gathering, or what divides one gathering from the next; but this is what happens in a certain place near my home. On a common there are three small ponds of much the same size, depth and shape, all of them close together. Each of them has a gravel bottom and each the same kind of aquatic vegetation. Yet in the spring one of the ponds will be alive with spawning toads and in the other two there will be no toads at all. Always one pond is chosen and the others not, and it is the same pond every year. No doubt there is some good toadish reason for this, but so far the toad fraternity have kept it a secret from me.

Most of us have heard the wonderful stories of toads being found embedded alive in solid rock in which they have been "imprisoned for centuries". This, of course, is complete nonsense. The idea may have arisen from the fact that toads sometimes hibernate in clay which later dries and hardens and so encloses them. It has been proved by experiment that, provided the lump is porous, a toad can live and breathe thus immured up to eighteen months, but this seems to be the longest time that any toad can go without food and live.

In my view no greenhouse is complete without one or more toads, and, until the time comes for them to hibernate or to leave for their spring spawning grounds, they will stay as long as there is food for them. Any reader who wishes to know whether his greenhouse is thus blessed is advised to give the place a general sprinkling with a fine hose at dusk one summer evening. There seems to be no evidence that toads ever drink, but few of them can resist the pleasure of a shower bath of this kind and most of them will come out with eagerness for it. Theophilus loved it, and rarely failed to respond to the invitation of the hose. There is one story of a toad that nightly took a bath beneath the dripping tap of a water butt, turning round and round so that the water might reach every part of its body. It could be true.

Any gardener who has toads in his garden is to be congratulated. Anyone who has not will be well advised to "import" a few if he can get them, taking care that they are introduced to their new quarters *after* they have finished their spring spawning. They will cost nothing and will keep themselves, and in the keeping will do work that is worth time and money to any good gardener. There are few if any living things that do more good, and certainly none that do less harm.

NITROGENOUS TOP DRESSING OF SPRING CABBAGE

R. B. Castle, B.Sc.(Hort.)

Department of Horticulture, University of Reading

TOP dressing of spring cabbage with readily available nitrogenous fertilizers such as nitrate of soda or sulphate of ammonia in the early part of the year is standard practice with most growers. There are, however, some who favour the application of nitrogen in the autumn instead of,

or in addition to, spring dressings. An experiment was carried out to test the effect of nitrate of soda applied in autumn and/or spring on the growth and yield of the crop at the Reading University Horticultural Station in the 1947-48 season. The soil here is a medium heavy loam derived from the London Clay, with some plateau gravel. It was manured at the rate of 12 tons of straw compost per acre, followed by a base dressing of 4 cwt. superphosphate and 1 cwt. muriate of potash. Although on the whole the winter was mild, there were some very cold spells.

The experiment consisted of three randomized blocks (each consisting of sixteen plots of 16 sq. yards), covering four varieties of spring cabbage—Early Giant, Harbinger, Flower of Spring, and Early Market. Planting was carried out on Sept. 30 and Oct. 1, 1947 and gapping-up completed by Oct. 24. Nitrate of soda was applied at the rate of 3 cwt. per acre for each application, and four treatments were given to each variety.

Nitrogen applied	Early Giant		Harbinger		Flower of Spring		Early Market	
	No. of plants	Yield	No. of plants	Yield	No. of plants	Yield	No. of plants	Yield
		lb.		*lb.*		*lb.*		*lb.*
Autumn (Nov. 5 1947)	55	15.0	118	25.5	125	35.0	105	32.0
Spring (Mar. 3 1948)	90	39.0	123	42.5	140	60.0	167	71.0
Autumn and Spring	33	9.0	114	46.0	122	38.5	91	37.5
Control (No Nitrogen)	51	15.0	101	18.0	136	33.0	107	25.0

The crop was harvested as saleable spring greens over the period May 3-6.

The application of nitrogen in the autumn markedly increased the loss of plants in winter but produced no significant effect upon final yield. Spring application of the fertilizer, however, resulted in over four times the total yield of marketable greens given by the control.

Winter losses were reasonably attributable to low temperatures rather than to any other factor. Susceptibility to winter killing differed significantly between varieties, Early Giant being the most susceptible and Flower of Spring the least. Though the application of nitrogen in autumn increased winter losses, this effect was approximately the same with all varieties; that is, there was no interaction between variety and treatment. The autumn application appeared to produce a softer and more succulent growth, easily damaged by frost.

It must be emphasized that these results apply to a single experiment in one season on a particular soil. Before any general conclusion is permissible, the experiment would have to be repeated on a variety of soils and over successive seasons.

More Sheep Our sheep population has fallen by more than a quarter since 1939; and there is little sign yet of any recovery. Our meat allowance is deplorably low. Any increase, however small, would be widely welcomed. Sheep can be bred and fattened with less supplementary feeding than any other farm animal—and that is important with present restrictions on cereals and oilseed by-products for feeding. Having a much shorter breeding, rearing and fattening cycle than cattle, sheep can do much more to help our food problem than is generally recognized. Going through parts of England today, one is impressed by the absence of sheep from many farms where they should be kept. There are new leys as well as old pastures which could support more livestock.

Why are sheep so unpopular? They are still kept on the hills and moorlands because there is no alternative; but on mixed and mainly arable farms they are disappearing fast. On mixed farms we should now be increasing our sheep, not in competition with dairy cattle, but as supplementary livestock. What unconsumed waste there is! Undergrazed leys and stubbles, ploughed-in sugar-beet tops and market-garden crops, untrimmed growth on hedge banks—all potential meat and animal fat.

It is easy to explain the rapid decline in flocks kept under wholly intensive folding conditions on the eastern and southern arable farms. The wholly arable system is costly in labour, though it will always persist in pedigree ram breeding Down flocks. But there is much scope for developing mixed farm flocks fed on tillage crops during winter and spring, and grazed on leys for the rest of the year. And we must abandon the idea that sheep are a lot of trouble for the profit they make. Great advances in disease control have been made during the past twenty years: for example, phenothiazine to control stomach worm infestation, DDT preparations for maggot-fly strike, modern serum and vacine treatment against diseases like pulpy kidney and lamb dysentry.

At present-day guaranteed prices for mutton and lamb, a sheep enterprise should be profitable, if we keep down losses and manage the flock to get a good crop of lambs. It is essential that sheep should make a proper contribution to the four-year expansion programme. Even when world supplies are more plentiful, home-killed lamb and mutton are likely to be in good demand.

A Low Form of Newcastle Disease in Great Britain Fowl pest (Newcastle disease) was introduced into this country in the early part of 1947 by the importation of frozen poultry carcasses from Europe. Steps have been taken by slaughter and control of movement to get rid of infection and, in the case of poultry from Europe, by restricting importation to eviscerated carcasses to reduce the introduction of further infection to a minimum. On the whole the results have been satisfactory. Outbreaks are, however, still occurring in widely separated districts, and there can be no doubt, therefore, that there are still centres of unreported disease in this country.

There are at least two forms of Newcastle disease. One, the European form, is more virulent than the form now prevalent in the U.S.A. Until recently there was no reason to think that a low form of the disease existed in this country but, as a result of the testing of some birds that had been entered in certain laying trials, it has been proved that a low form of Newcastle disease does exist here. In dealing with outbreaks of the more virulent (European) form of fowl pest, it is the normal practice of the Ministry of

Agriculture to make extensive inquiries with a view to determining the origin of infection and also to ascertain how far the infection may have been spread.

In connection with one outbreak, these inquiries led to the examination of certain birds at some laying trials, although the birds at those trials had not had, so far as is known, any actual contact with diseased stock. The health records and egg production of the birds at the trials were found to be satisfactory, but on making blood tests it became evident that some of the birds were or had been affected with Newcastle disease. Subsequent re-tests of the birds at the trials showed that none of those that had reacted at the time of the first tests had communicated any reaction to the birds with which they were in contact. This seems to suggest that the reacting birds had recovered from the disease when they entered the trials and had not been responsible for transmitting infection to other poultry.

In consequence of what was discovered as a result of the testing of birds at the laying trials, the Ministry undertook the testing of birds on the home premises of a number of poultry-keepers who had sent birds to the trials. Those tests disclosed that there were reacting birds on the home premises also. Further tests have revealed reacting birds on some large hatcheries, and in the case of one hatchery it was discovered that nearly three years ago trouble had been experienced with young chicks (2–4 weeks old) but that the only symptoms the chicks had displayed were similar to those normally associated with slight colds : there was no unusual mortality.

The low form of Newcastle disease existing in this country is similar to that which has been recognized for many years in U.S.A. though, if anything, it is of a less virulent nature, since in U.S.A. the disease has been responsible for a serious decline in egg production. In this country nothing of that kind has been discovered.

Owing to the wide distribution of birds from hatcheries and rearers over a period of years, the dispersal of birds that would react to blood tests as a result of this low form of Newcastle disease must have been extensive. There is no information to show what proportion of reactors carry this low form of infection, nor what is the likelihood of the infection assuming a more virulent character. Since, however, this low form of the disease has existed in this country probably for three years and, so far as is known, there is nothing to suggest that before the importation of the more virulent (European) form it has ever assumed a virulent character, the experience in this country seems to be reassuring on this point.

Although there is no data on which a positive statement can be made that this low form of disease exists in many districts, the Ministry can only conclude that it must be present on many premises. The blood testing to determine whether or not birds are or have been affected by Newcastle disease is a delicate one, occupying much time and calling for the services of highly trained staff ; its application on a wide scale in the field would, therefore, be impracticable. For these reasons, and because it could not be diagnosed clinically —frequently birds affected with this low form show no signs of disease or ill-health—it is clearly impossible to deal with this form of the disease by the slaughter method. That method is suitable and is being pursued against the more virulent (European) form of the disease. Should, however, this low form of Newcastle disease assume a form which could be recognized clinically, it would be dealt with on the same lines as those followed for the European form.

Vegetable Oil One of the most serious shortages caused by the war is that of oils and fats. Not only is there a substantial decline in the world production of these essential commodities, but there is

an even greater reduction in the quantities entering international trade, and at the present time in very few of the more important consuming countries is the total supply available more than 75 per cent of the quantity consumed before the war ; in many of these countries consumption is little more than 50 or 60 per cent of the pre-war level. One of the primary causes of this deficiency is the war-time dislocation of the trade in vegetable oils and oil-seeds, and it is largely from the restoration and expansion of this trade that increased supplies of oils and fats generally must be expected. But the rate of recovery so far has been slow.

A survey* recently issued by the Commonwealth Economic Committee shows that the world production of oils and fats of all kinds in the years just before the war amounted, on the average, to between 21 and 22 million tons a year, of which the oil equivalent of the oilseed crops represented roughly three-fifths and animal fats and marine oils the remaining two-fifths. World exports averaged about $5\frac{3}{4}$ millions tons a year, and of this total, vegetable oils, including oilseeds in terms of oil, accounted for $4\frac{1}{4}$ million tons, while animal fats and marine oils, chiefly whale oil, each provided some $\frac{3}{4}$ million tons. In 1946 the estimated world production was under 20 per cent less than the pre-war average, but the total quantity of oils and fats which entered world trade fell by more than 50 per cent ; the total amounted to only $2\frac{3}{4}$ million tons, vegetable oils constituting 2 million tons, and animal fats the bulk of the remainder.

Various demand and supply factors have contributed to the creation of the present situation. The demand for oils and fats has been increased by the normal rise in populations and by technical developments which have tended to raise the actual or potential consumption both in consuming and in producing countries. In continental Europe, the decline in numbers of dairy cows and pigs, formerly the chief source of that area's fat supply, has resulted in a greatly reduced output of animal fats and, in consequence, a greatly increased demand for imported vegetable oils. The reduced whaling operations have also deprived these, and other, countries of large supplies of oil. The greatest single factor on the supply side, however, has been the tremendous reduction in the supplies of vegetable oils and oil-seeds from the countries in the Far East which were occupied by the Japanese. Before the war these countries, chiefly Malaya, the Netherlands East Indies, the Philippine Islands, China and Manchuria, provided roughly 40 per cent of the total world exports of vegetable oils and oilseeds and, although there has been some recovery, notably in the Philippines, the supplies available for export are still very much below the pre-war level. Another significant factor has been the critical food situation in India, which has led to some change-over from oil-bearing crops to grain and pulse crops and a restriction of exports to meet increased domestic requirements. This increased retention of oils and oilseeds for domestic consumption is a development which has occurred also in other producing countries, notably in South America. Production in the British and Belgian colonies in Africa was fairly well maintained throughout the war, and these territories are now among the chief exporters of vegetable oils and oilseeds.

The Commonwealth is an important producer of all the principal oilseeds except the soya bean and sunflower seed, and in the years just before the war it provided about a quarter of the estimated total world production and one-third of total world exports. Production has been fairly well maintained since the beginning of the war and the Commonwealth has fully retained its

* *Vegetable Oils and Oilseeds, 1948.* Price 5s. (5s. 3d. by post) from H.M. Stationery Office, the Secretary, Commonwealth Economic Committee, 2, Queen Anne's Gate Buildings, Dartmouth Street, London, S.W.1., or through any bookseller.

pre-war share. Exports from Commonwealth sources became increasingly important during the war and in some years accounted for more than half the world totals. The restriction of exports from India and the relatively slow recovery in Malaya have, however, had a serious effect on the Commonwealth's share of the world trade since 1945, and exports from the Commonwealth in 1946 and 1947 represented only about 30 per cent of the totals. In both years Nigeria was by far the most important source of supply. The East African Groundnut Scheme, now in its early stages, is likely to result in greatly expanded exports from East Africa, hitherto a relatively unimportant source, and schemes for increasing production in other areas are being considered.

Tractor Tyre Tests Several years ago a new design of tyre for the driving wheels of tractors was introduced in the U.S.A. The wheel rim was made wider, and the cross-section of the tyre shallower.

This design proved useful during the war because it helped to conserve rubber supplies, but it has been doubted whether these wide-based tyres were as efficient in transmitting the power of the tractor as were the conventional narrow-based tyres. These doubts came to the notice of the British Rubber Development Board, who, in 1946, invited the views of the firms interested in the manufacture of tractor tyres in Britain. A technical committee was formed to draw up a scheme of practical experiments to test this matter and to make comparisons of 4-ply and 6-ply tyres, since the wide-based tyres are in general thinner and more flexible, being made with fewer plies than the conventional narrow-based tyres. The experiments were carried out by the National Institute of Agricultural Engineering.

A report of these experiments has now been issued under the title *Experiments on Tractor Tyre Performance*, a limited number of copies of which are available free from The British Rubber Development Board, Market Buildings, Mark Lane, E.C.3.

The results show very little difference in performance between 11 × 36, 4-ply tyres on wide-based rims and 11 × 36, 4-ply tyres on narrow-based rims. The wide-based tyres were slightly better on loose land and slightly worse on firm land.

The difference in performance between 4-ply and 6-ply tyres also is very small, the 4-ply tyres being just a little more efficient.

Some experiments on the effect of liquid ballast on tyre performance were included in the scheme of work. The results showed that the nature of the tyre filling, whether 100 per cent air, 100 per cent water, or 95 per cent water or 75 per cent water, made very little difference in the drawbar performance of the tractor, provided the total back axle weight was kept constant by adding or subtracting suitable amounts of cast-iron ballast. It was found, too, that unless the tube is filled completely with water, the proportion of water ballast does not have any marked influence on the incidence of side-wall wrinkling, a condition which may bring rapid deterioration of the tyre. Complete filling, however, does enable an appreciably higher tyre deflection to be used before wrinkling occurs at a given drawbar load.

The Lapwing From many parts of the country the Ministry has been asked, "What has happened to our lapwings ?"

There is, unfortunately, no doubt that in many districts the lapwing is scarcer than it has been for a long time past. Many reasons for this have been suggested, but it is probable that the exceptionally severe winter of 1946-47 was the main cause. Essentially a ground-feeding bird, with the earth frozen iron hard or deep in snow for weeks on end, it was inevitable that the species would be badly hit. The casualty list was indeed a heavy one.

The lapwing is a handsome bird, and its stance and movements are at all times graceful and stately. It combines beauty and usefulness in a high degree and it is very much an asset to our countryside.

Apart from its great value to agriculture generally, the lapwing has three especial claims to fame. It has an Act of Parliament all to itself (The Protection of Lapwings Act, 1928); it is one of the greatest destroyers of the water-snail *Limnea truncatula*, which harbours the early form of the liver fluke of sheep; and at least one lapwing has been proved by "ringing" to have flown the Atlantic.

All who are concerned with food production will hope that the lapwing's decline will be only temporary, and that the favourable spring this year will have helped the species to recover at least some of its lost ground.

AGRICULTURAL MACHINERY—ENGLAND AND WALES

1948 CENSUS

Estimated numbers of certain machines and implements owned at the census date by occupiers of agricultural holdings, agricultural contractors and County Agricultural Executive Committees, with comparative figures for the 1946 census.

Machine or Implement	*January 1946*	*January 1948*
Tractors:		
Tracklayers	11310	13890
Three and four-wheeled Tractors	153650	193530
One and two-wheeled Tractors	14890	23860
Total Tractors	**179850**	**231280**
Petrol and Oil Engines	154640	173620
Electric Motors	47920	60990
Wagons and Carts	596360	463370
Lorries and Vans	57850	85860
Liquid Manure Carts	10170	12170
Tractor Trailers	78940	146680
Spraying Machinery:		
Power Fruit Sprayers	5670	6610
Wheeled Potato and Charlock Sprayers	3440	3280
Mould Board Ploughs:		
Horse: One, Two or Three-furrow	247170	171180
Tractor	155580	214510
Ridging Ploughs:		
Horse	124290	122690
Tractor	23150	35560
Cultivators, Grubbers or Scufflers:		
Horse	117730	108580
Tractor	83220	100710
Hoes:		
Horse	166440	164430
Tractor	11250	18780
Toolbars: Tractor	27280	38340
Harrows:		
Disc	55820	65410
Fixed Tooth and Drag	417170	414120
Spring Tooth	88130	90530
Chain and Flexible	145810	147630
Other Harrows: seed, special purpose, etc.	341040	331650

—continued overleaf

AGRICULTURAL MACHINERY—ENGLAND AND WALES

Machine or Implement	*January 1946*	*January 1948*
Rollers and Presses	205320	193500
Corn Drills	89630	89810
Combined Seed and Fertilizer Drills	16110	19680
Root Drills	82320	84640
Broadcasters : Horse- and Tractor-drawn	9620	11340
Fertilizer Distributors over 5 ft. wide	65600	74830
Potato Planters	5730	7120
Seedling Transplanters	3040	4060
Mowers over 3 ft. wide :		
Horse	150980	135190
Tractor	48200	66710
Side Rakes and Swath Turners	116690	120280
Hay Tedders	47310	46260
Hay Rakes	178790	180050
Hay Sweeps	80010	87150
Hay Loaders	24180	25770
Hay Grabs	10020	9970
Stook Loaders	680	700
Hay, Corn and Straw Elevators	38080	45620
Binders	119390	119080
Combined Harvester-Threshers	3250	4970
Green Crop Cutter-Collectors	590	800
Green Crop Loaders	730	1000
Silage Cutters and Blowers	(a)	1050
Potato Spinners	46980	52340
Potato Chain Elevator Diggers	3770	4600
Sugar-Beet Lifting Ploughs	28410	29150
Sugar-Beet Loaders	380	720
Sugar-Beet Harvesters	180	230
Portable Threshing Machines with drum width 2 ft. 3 in. or over	12840	13600
Hay and Straw Balers :		
Stationary	4240	5800
Pick-up	1720	1820
Chaff Cutters	120390	107630
Root Cutters and Pulpers	177860	164120
Potato Sorters :		
Hand : Not Riddles	(a)	25840
Power	(a)	8260
Grinding Mills : Power operated	79680	80960
Hammer Mills	8460	12820
Meal Mixers	1070	1230
Grass Driers	230	320
Grain Driers	1000	1130
Winnowers and Cleaners : Power operated	1730	8250
Shearing and Clipping Machines	53410	50560
Liquid Manure Pumps	9580	8470
Milking Machines	40360	48130
Sterilizing Chests	35170	39960
Milk Coolers	103560	107300
Dairy Boilers	40550	45110

(a) Not collected.

NOTE : Corresponding figures for Scotland are being published by the Department of Agriculture for Scotland.

THE MINISTRY'S PUBLICATIONS

Since the date of the list published in the June, 1948, issue of *Agriculture* (p. 132), the undermentioned publications have been issued.

Bulletins Copies are obtainable at the prices mentioned from the Sales Offices of H.M. Stationery Office or through any bookseller.

No. 48 Rations for Livestock (*Revised*) 2s. 6d. (2s. 9d. by post).

Advisory and Animal Health Leaflets Single copies of not more than 16 leaflets (four in any one group) may be obtained, free of charge, on application to the Ministry, 1-3 St. Andrew's Place, Regent's Park, London, N.W.1. Copies beyond this limit must be purchased from the Sales Offices of H.M. Stationery Office, price 1d. each net (2d. by post), or 9d. net per doz. (11d. by post).

Group I. Livestock and Dairying
No. 6 Blackquarter, Quarter Ill or Blackleg (*Revised*).
No. 83 Swine Fever (*New*).

Group III. Pests and Diseases of Fruit Crops
(a) Insects and Other Pests.
No. 334 Pea Moth (*New*).

Group V. Other Subjects
No. 297 Sweet Corn (*Revised*).

Animal Health Leaflets
No. 1 Nutritional Anæmia of Young Pigs (*New*).
No. 2 Coccidiosis in Poultry (*Revised*—superseding Advisory Leaflet No. 16).
No. 6 Fluke or Liver Rot in Sheep (*Revised*—superseding Advisory Leaflet No. 310).
No. 8 Infanticity in Cattle (*New*).

Other Publications
Green Crop Drying in Holland, Sweden and Denmark. *Agriculture Overseas Report No.* 7. 1s. 3d. (1s. 5d. by post).

AGRICULTURAL INDEX NUMBER

Monthly Index Numbers of Prices of Agricultural Products Including Government Grants. (Base 1927–29 = 100)

Month	Uncorrected for Seasonal Variation					*Corrected for Seasonal Variation*				
	1939	1945	1946	1947	1948	*1939*	*1945*	*1946*	*1947*	*1948*
January ..	95	192	199	217†	†241	*89*	*173*	*179*	*193*†	†*215*
February	94	193	201	211†	†240	*88*	*176*	*182*	*190*†	†*217*
March ..	91	185	192	201†	†232	*91*	*178*	*183*	*191*†	†*220*
April ..	90	167	176	186†	†214	*95*	*173*	*182*	*192*†	†*222*
May ..	82	154	162	171†	†198	*91*	*173*	*181*	*192*†	†*223*
June ..	80	154	161	170†	†197	*89*	*174*	*181*	*193*†	†*225*
July ..	85	162	168†	181†		*93*	*177*	*182*†	*197*†	
August ..	86	162	176†	192†		*91*	*174*	*191*†	*208*†	
September	92	159	177†	206†		*93*	*166*	*188*†	*222*†	
October ..	96	179	192†	221†		*92*	*172*	*187*†	*215*†	
November	106	191	209†	235†		*98*	*177*	*192*†	*217*†	
December	113	197	214†	240†		*103*	*178*	*192*†	*216*†	

†Provisional

BOOK REVIEWS

Broad Acres : A Yorkshire Miscellany ALFRED J. BROWN. Country Life. 18s.

Extending over more than one-tenth of the total area of England and Wales, Yorkshire presents rather a problem to a writer aspiring to deal with his subject within the scope of one volume. In his most recent book *Broad Acres*, Mr. A. J. Brown has obviously given serious thought to the words of the late J. S. Fletcher, which he quotes, and in an extremely readable and enjoyable manner provides a properly balanced ration containing the ingredients required for a healthy growth of understanding of this large county.

It is obvious that many years of walking, talking, research and thought have been involved in the preparation of this work, and the way in which the author selects some of the outstanding features of the county will delight those familiar with the subject and serve as an admirable introduction and incentive to those who are not.

The forty-nine well-chosen full-page photographs add a graceful touch to the text and in themselves convey a lasting impression of the infinite variety in the make-up of Yorkshire—the breath-taking rugged grandeur of Bempton Cliffs, the snug harbour of Whitby with the quaint old town nestling beneath the cliff and abbey ruins ; there is the Brontë countryside and village of Haworth in all its bleakness, neat Coxwold of Tristram Shandy fame, the awe-inspiring birthplace of the Aire at Malham Cove, the gracious ruins of Rievaulx and Fountains Abbeys, the challenging peaks of Whernside, Ingleborough, and Penyghent, the friendly atmosphere of Helmsley, where Wordsworth and his Yorkshire wife stayed on their honeymoon, the comforting shelter of the white city walls at York, and the towering dignity of the Minster, the bluff defiance of Skipton Castle in sharp contrast to homely villages and farms of Wold, Pennine, Hambleton, Cleveland and Vale of York country. All these and many more add their colour to the author's pen.

Mr. Brown's walking prowess is now well known, and in these days of mass entertainment and urban living it is most refreshing to read of the urge to rise at daybreak, to follow a river to its source, to stride all day across the moor tops, eventually to partake of true Yorkshire hospitality and to chat with the farming folk. Contact with these surroundings and a truer realization of the gradual historical development of our countryside is a healthy relief from the pace of our high-pressure civilization. It gives a sense of continuity and permanence which is so often lacking today.

Farming readers may wish that the author could look at their activities with a rather more knowledgeable and understanding eye. But this is a very minor criticism and will, I expect and hope, be less justified when, in the fullness of time, Mr. Brown completes his next book on Yorkshire.

W.W.G.

Plant Diseases. F. C. BAWDEN. Nelson. 7s. 6d.

Although in no sense a textbook for the professional plant pathologist, this book, one of the first volumes in the publisher's new Agriculture Series, edited by W. G. Ogg and G. V. Jacks, is a work of special value to agriculturists and horticulturists, and also to students. In plain understandable language the author covers the whole field of plant pathology as it concerns the crops grown in Britain. Early in his book (p. 4) the author touches upon the frequently encountered theory that disease conditions in plants are fostered, if not caused, by the use of mineral or so-called "artificial" fertilizers. His brief but convincing examination of this theroy will do much to dissipate the enthusiastic doctrines of the "apostles of humus" and leave the reader with a balanced view. Such important factors as environment and biological specialization of parasitic organisms are fully examined.

There is a valuable chapter on "physiological diseases" ; valuable because today it is recognized that crop plants deprived of a major or minor nutrient element often develop symptoms little removed from a diseased condition.

In the closing pages of the book the reader is reminded that there has been a State medical service for crop plants in Britain for some twenty years, but it has been inadequately used. Now that this service has been incorporated in the National Agricultural Advisory Service, its extension may lead to a wider application of known methods of disease control and do much to improve the general health of our crops. All farmers should read this remarkable and extremely interesting book, for it will help them to obtain a clear understanding of a subject that vitally affects their business.

A.H.H.

New Varieties of the Potato. LEAFLET No. 2. DEPARTMENT OF AGRICULTURE FOR SCOTLAND. 3d. (4d. by post).

In this new leaflet the Department of Agriculture for Scotland has brought up-to-date the list of recently introduced potato varieties. The grouping is so arranged that special reference is made to registration under the Scottish Registration Scheme, whereby new varieties are accepted from raisers who wish to have their new seedlings thoroughly tested, and those found to be worthy of introduction into commerce are brought to the notice of the industry.

The leaflet covers thirty varieties arranged in seven groups. Group 1, for instance, includes Craigs Snow-White and Orion, both registered in 1947, and in Group 3 is found Craigs Bounty which failed to qualify for registration, owing to its undesirable feature of producing long runners. These are the first Blight-resistant varieties introduced into British agriculture, and indicate the progress being made in this sphere of potato culture.

A variety mentioned in Group 2 is Home Guard, which was refused registration in 1936, when it was stated to be "insufficiently outstanding," but, despite this lack of recognition at that time, it has attained a high place in Scottish seed production—5,983 acres being grown in Scotland in 1947. One of the reasons given for this popularity is that it does not appear to suffer from Dry Rot—a disease which causes much trouble during storage.

Group 5 includes eight varieties, with a warning as to their defects and no recommendation that they should be grown. For instance, three of these—Doon Eire, Doon Castle and Doon Well—enjoyed only a short commercial life, owing to their pronounced susceptibility to Blight and storage diseases.

Eleven of the thirty varieties listed are " New Irish Varieties," and include Ulster Chieftain, the oldest of the Ulster series, and Ulster Prince, a promising early known under test as seedling 1034. Also in the group are two of the "new-type" earlies, Ulster Premier and Ulster Ensign; both produce kidney-shaped potatoes with red colour in and around the eyes. The remainder in this group could be classed as Majestic alternatives.

It will be interesting to see how many of the new varieties mentioned in the leaflet "stay the course". Already some are noted that they will not be marketed by the raiser, or may be withdrawn from commerce owing to defects which have appeared since the varieties were named.

N.McD.

Journal of the British Grassland Society, Vol. 3, No. 2, June, 1948.

This issue contains a number of contributions of wide interests to advisory officers, farmers, and research workers. Linehan, McConaghy and Stewart have contributed an account of the grasslands of Northern Ireland, which describes their present management, potentialities of increased production and the difficulties which will be encountered in the improvement of the pastures of the region. There is also a paper written by Turner as a study of the utilization of all stock food consumed on a dairy farm in county Armagh with special reference to the output of the grassland area used for hay, silage and grazing.

Many people may consider that quality, and hence the productivity, of British permanent grass is a relatively stable attribute. A survey in Buckinghamshire of a sample area of some 3,500 acres on three occasions—in 1935, 1942, and 1947—described by Davis, shows that very marked changes have occurred in the botanical composition during this period, and in the majority of fields such changes would indicate a deterioration in productivity. The surveys of 1942 and 1947 also show the changes in land utilization necessitated by war conditions.

A review of the literature, by Weinmann, on the underground development and reserves of grasses, emphasizes the importance of the sub-aerial organs upon the productivity and persistency of perennial grasses. They are the organs for storage of reserves which, if depleted by judicious seasonal management, manifests itself in undesirable sward changes.

In a contribution on studies on the biochemistry of pasture plants, Davies, Evans (R.A.) and Evans (W.C.) describe a new technique for the preparation and preservation of herbage samples, namely, the freeze-dry method. The technique, with laboratory equipment developed for work on pasture plants is fully described.

Other contributions to this issue consist of a communication by Watkins and Armado Chavez on forage supply for the dry season in El Salvador, and notes on certain grassland problems in certain areas of the United Kingdom and Sweden.

T.E.W.

Eggs from Every Cage H. E. SWEPSTONE. Littlebury and Co., 7s. 6d.

As the title indicates *Eggs from Every Cage* deals with the battery system of poultry-keeping: it is, in point of fact, a collection of material previously published as articles in the poultry press. Mr. Swepstone is no newcomer to the industry; he has been keeping laying birds in batteries for nearly twenty-five years, and he writes authoritatively on his subject. It is his own system which he describes, a system which he evolved by trial and error.

A fair picture is presented of the sort of costs and returns which may be expected from this type of enterprise, and useful information is embodied as to the kind of equipment the author himself has found suitable; the more modern labour-saving devices, such as those for automatic watering and cleaning are not included. Stock replacements, labour, and general management are also discussed.

The prices quoted are those which were current when the articles originally appeared and are, therefore, not strictly applicable to present-day conditions. Nevertheless the information is set out in such a way that it is possible to substitute ruling prices, and anyone contemplating embarking on this type of enterprise can work out probable costs and returns without difficulty.

The question always arises in relation to a book of this kind, whether it is advisable for a layman to enter on a discussion of diseases and their cure. Mr. Swepstone, however, says little about this, but I thought that his suggestions for dealing with prolapsus and swollen crop are likely to be quite helpful. *J.W.S.*

Vegetables and Salads, including Herbs. MINISTRY OF FOOD. H.M. Stationery Office. 6d. (7d. by post.)

The Ministry of Food recently launched a new series of popular and colourful bulletins on specific subjects designed to replace their attractive leaflets issued during the war. *Fish Cookery* has already appeared, and the present bulletin on vegetables is the second of the series.

The booklet fills a long-felt want by supplying the basic information needed by the young housewife without much domestic training. It is well prepared, the text clear and concise, and the line drawings which illustrate most of the operations leave no doubt as to the exact manner in which they should be performed. The illustrations of herbs are commendable and would assist the amateur to recognize some of the lesser-known kinds but for the fact that they are not identified exactly with the relevant descriptive paragraphs.

The subject-matter includes a general section on the choosing, storing and preparing of vegetables, and the basic methods of cooking; also a detailed alphabetical list of the treatment and best methods of cooking all the common vegetables and some not so well known. (It will be noted that celeriac, chicory, corn cobs, kohlrabi, and nettles are included, but sugar peas, salsify and scorzonera, Chinese artichokes and other delicacies for the connoisseur are not.) A short section on salads describes how to prepare and use them, and this is followed by a good chapter on herbs, with information on when to gather, how to use, and how to dry them for winter use. The large recipe section includes sauces and salad dressings; soups made mainly from vegetables; methods of cooking vegetables to serve with meat or fish or (most important in these days) as main meal dishes in themselves; sandwich spreads; and sweet dishes. The booklet ends with a page of handy measures, invaluable to the housewife without scales.

The Ministry of Food is to be congratulated upon this start to a very useful series, as basic cookery information has been needed for a long time and was virtually unobtainable in simple form. More especially in this country is there a need for the better cooking of vegetables. As the introducton states, no country in the world can grow better vegetables than ours—at least this applies to the really first-grade produce of the market gardener—but seldom are they cooked attractively. This booklet should therefore have a wide appeal and assist in no small measure to introduce into many homes these qualities of imagination and variety which have for so long been absent from our kitchens. *M.M.*

3730 Wt. 15 CN&Co 9/48 466

M A F
Standard Buildings

Your enquiries for
Ministry of Agriculture
Standard Buildings
for all farm purposes
will be welcomed by

THE MARLEY TILE COMPANY LIMITED

London Road, Riverhead, Sevenoaks, Kent

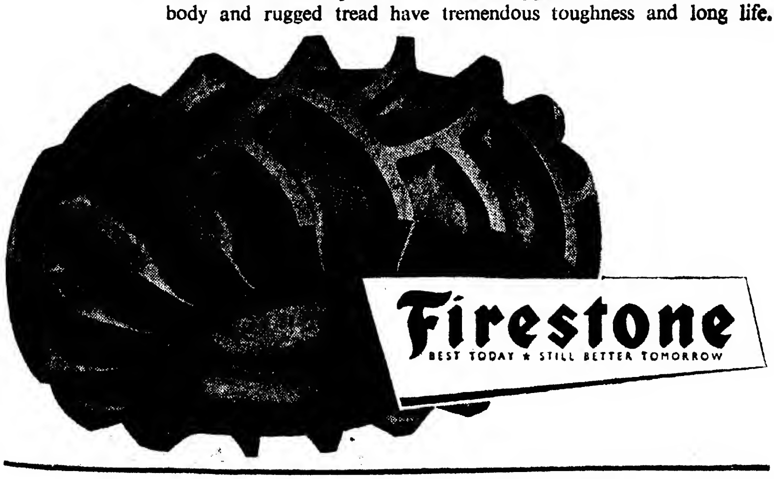
Telephone: Sevenoaks 2251/8

Also available:
Marley Hay Barns, Piggeries, Silos, etc.

12-13 St. George St., Hanover Sq., W.1. *Mayfair 7444*

'No other Tractor tyre really satisfies me now'

Deep traction bars angled for self-cleaning, each strongly braced by three supporting bars. The unique 'centre bite' transmits maximum drawbar-pull. The rubber dipped, friction-insulated cord body and rugged tread have tremendous toughness and long life.



Please mention the JOURNAL *when corresponding with Advertisers*

Please mention the JOURNAL *when corresponding with Advertisers*

Agriculture

PUBLISHED 6d MONTHLY

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

Editorial Offices: St. Andrews's Place, Regent's Park, N.W.1 (*Phone: WELbeck* 7711)

VOL. LV | No. 7 | OCTOBER 1948

Contents

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LV No. 7 OCTOBER 1948

CHEVIOT SHEEP

ALLAN FRASER, B.Sc., M.D.
Lecturer in Animal Husbandry, University of Aberdeen

I INTEND writing this article largely in the first person singular, because to venture on discussion of the value of Cheviot sheep in comparison with other sheep breeds—still more to venture a comparison between the Cheviots of one type and that of another—is to step on ground so controversial that dogmatism would be absurd. There is neither such secure evidence nor consensus of expert opinion to permit of any man setting himself up as a judge. Yet every man is entitled to his personal views and to their frank expression.

I think, then, that the first thing to acknowledge and confess about the modern Cheviot, as of most other sheep breeds, is that it is of very mixed ancestry and of very mixed type.

Take, first, this question of ancestry. That there were sheep of some sort on the Cheviot hills from the very dawn of documented history is universally acknowledged, but as to the type of sheep kept in that pastoral region before the latter half of the eighteenth century, the evidence is too scanty and speculative to merit discussion.

When men first began to think and write seriously of sheep improvement, they seem to have been surprised by the class of sheep the Cheviot hills maintained. Thus Sir John Sinclair wrote in 1792 :

" Perhaps there is no part of the whole island where, at first sight, a fine woolled breed of sheep is less to be expected than among the Cheviot hills."

Youatt, in his time, agreed that it was something of a mystery how the sheep native to the Cheviots ever got there :

" Tradition says that they came from the border districts of Scotland ; but they are totally different from the black-faced sheep, and bear little or no resemblance to the original dun-faced Scottish stock. How two breeds, so totally different from each other, came to inhabit the neighbouring districts of Ettrick forest and the Cheviot hills, neither history nor tradition has attempted to explain."(1)

Discovery and Improvement of the Cheviot

Actually, the discovery of this valuable sheep breed, tucked away in hidden country, was no mere accident. It was due to the initiative and energy of Sir John Sinclair of Ulbster in Caithness and the Wool Society which he founded. The story is told by Sir Archibald Sinclair in the first volume of the Flock Book of the North Country Cheviot Sheep Society. He writes there :

" Sir John Sinclair of Ulbster in the County of Caithness (afterwards first President of the Board of Agriculture) was instrumental in forming the British Wool Society, which held its first meeting in Edinburgh in January,

1791. In the course of one year from that date the Society accumulated about 800 sheep, natives of all countries from Sweden to Abyssinia and from Shetland to South Wales. These sheep were distributed all over Scotland to flockmasters who undertook to make experiments contemplated by the Society. The Chairman, Sir John Sinclair, several other members, and experienced and intelligent agents made tours of observation in pastoral districts and furnished valuable reports to the Society.

"To one of these reports Sir John Sinclair annexed an account of the 'long hill sheep,' to which he gave the name of 'Cheviot,' stating as his reason that it was found in greatest perfection among the Cheviot hills and that he wished to name it after a district so memorable both in the history and in the legends of the country."

The energy and enterprise of the landowners and rich farmers of the late eighteenth century have never been surpassed in the annals of our country. On the credit of the livestock and other agricultural improvements they initiated, we continue to live. Yet, in their ideas of livestock improvement there resided a major fallacy—or so it appears to me—that persists to this day.

The fallacy—if it be a fallacy—was this. When a squire or prosperous farmer of those days desired to improve the livestock of his farm or district, he bestrode a horse and rode away in search of something better. Inevitably, if he rode far enough, he reached country where the land was better, the crops were better, and *consequently*, where the stock was better. He was, undoubtedly—as we still are today—inclined to forget the fundamental importance of that one word "consequently". He was apt to imagine that he had only to import this better stock from better agricultural districts to secure a notable improvement in the stock he had left at home.

In the history of the Cheviot breed, Mr. James Robson, of Belford, Roxburghshire, a farm in the lovely vale of Bowmont Water, was one of the first to go a-riding.

"Like Bakewell, he travelled through England to find the sheep best suited for his purpose. These he found in Lincolnshire, and bought three rams from Mr. Mumby at Barton-upon-Humber. These were big, close-coated sheep. When mated with the narrow-shouldered, short-woolled ewes there was a vast improvement in the produce, particularly in the fore-quarters, while the wool clip increased by 20 per cent. Rams from Belford became very popular, and their influence spread all over and beyond the Cheviot hills."(2)

Continued Crossing The search for methods of improvement of the Cheviot, by crossing with rams of other breeds, went on for a long time after the pioneer enterprise of Mr. James Robson. The Improved Leicester breed, evolved by Robert Bakewell at the close of the eighteenth century, was undoubtedly used to increase the size and fleece weight of the original Cheviot, as it was used about the same time in so many other British sheep breeds.

Thus Varney, giving evidence before the House of Lords in 1828, made the following statement.

"Cheviot wool is deteriorated very much in point of hair, and will not make fine cloths now, as it once would. It is coarser and longer, a state attributable to the Cheviot having a partial cross of the Leicester."(3)

There was another, rather different, reason for mixed breeding of the original Border Cheviot. The Border hills at the time of Sir John Sinclair and the Wool Society which he founded were already stocked with other breeds than the Cheviot. By far the most numerous and important of these competing breeds was the "Short" or "Linton" breed, now called the

Scottish Blackface. When the Cheviot extended its range on the Cheviot hills, the extension was carried out by grading up from the Blackface stocks already existing there. Wallace wrote of :

"... large numbers of Blackfaced flocks being replaced by Cheviots through the use of Cheviot tups—during five or six generations—a practice followed owing to the greater value of Cheviot wool, but also owing to the impossibility of getting sheep to live that had not been bred on the unhealthy land in certain districts."(4)

Of course, provided grading up is pushed far enough, the improved stock become undistinguishable from the breed to which they are up-graded, but, owing to the occasional use of grade tups, this process of up-grading the Blackface to the Cheviot may not always have been carried to its conclusion. Thus, in discussing Varney's criticism of Cheviot wool in 1928, in which he attributed deterioration of the fleece to use of Leicester tups, Wallace wrote : " He might well have added, or of the Blackface heath breed."(4)

Now, in addition to extension of range in the Border country, the original Cheviot found a second outlet in the new sheep country of North Scotland—particularly in Sutherland and Caithness. Until the close of the eighteenth century these counties were predominantly cattle breeding counties, with no sheep farming on a large scale. Sir John Sinclair, in addition to his other activities, was the man responsible for bringing his favourite Cheviot sheep to his native county.

" In 1792 he brought 500 ewes from the Cheviot hills to his farm of Langwell in Caithness. That was the first step. In later years the Cheviots flocked in their thousands to Caithness, to Sutherland, and to other Highland counties."(5)

In this new, sheep-free area, Cheviot sheep throve extraordinarily well. They were not in any way acclimatized ; they were not bred on the ground ; and yet they throve—one of the outstanding historical examples of the value of clean ground to sheepbreeding.

Patrick Sellar recorded that :

" ... a very rapid increase of Cheviot sheep took place in Sutherland between 1805 (when they numbered a few hundreds) and 1820, resulting in the annual extraction from the Alpine plants of 20,000 carcasses of mutton and 100,000 fleeces of wool."(6).

It should be noted that this increase occurred without the necessity of grading up from other breeds already in occupation of the ground. It cannot be denied, therefore, that particularly in relation to the Scottish Blackface, the Cheviot had a better opportunity of retaining its original characteristics in its new northern home than in its original home in the Border hills.

There was, however, another reason for crossing the Cheviot in the far northern Scottish counties, for, at one time, Merino sheep received quite an extensive trial there. Patrick Sellar, for example, wrote :

" I have bred up my Merino flock from two hundred to six hundred of as fine sheep of the kind, and as thriving too, as ever stepped on hill ground"—but added—"yet, I am about to cross them into Cheviot, and that on this account, they will not suit as a general stent for Sutherland."(7)

Two Distinct Breeds These various quotations suffice to show that the North Country Cheviot may have a slightly different ancestry, as it has a different history, from the South Country Cheviot of the Border hills. The latter must have undergone a much more extensive admixture with the Scottish Blackface. Both in all probability, and at various dates in their respective histories, have been crossed with the Leicester.

This evidence of a mixed ancestry is not a reflection upon the Cheviot breed of either type. Documented sheep history shows very clearly that when livestock improvement began, the mixture of the breeds native to different localities of Britain was very extensive indeed ; that the conception of breed purity and the value of pedigree is a later development. Even within more recent times, occasional crossing between recognized breeds has probably been much more extensive than is officially admitted or is generally supposed.

In any case it is clear that the distinction between North and South Country Cheviots evident today may have a basis in different ancestries. There is the further possibility that it may have been influenced by different aims of selection in two distinct and widely separated localities. Finally, it is conceivable that a difference in soil, climate and pastoral conditions has resulted in a separation of the Cheviot into two or more distinct types, although, on the basis of accepted genetical theory, it is difficult to visualize how this could occur. Were there sufficient evidence to assess the relative importance of these three possible factors, we should know a great deal more, not only of Cheviot sheep breeding, but of sheep breeding in general. Unfortunately there is not sufficient evidence to make such an assessment.

Whatever the reasons for the separation there can be no doubt that the Cheviot breed has now split into two distinct breeds.

(1) *The Cheviot.* This is very commonly referred to as the " Border " or " South Country " Cheviot, but these terms have no official recognition by any breed society. To those who breed them, this type of Cheviot remains *the* Cheviot. The Cheviot Sheep Society was founded in 1891, and issued a flock book (Vols. I and II) in 1893.

(2) *North Country Cheviot.* As a distinctive type, the North Country Cheviot has been accepted for many years, but its official recognition is of much more recent date. The North Country Sheep-Breeder's Association was founded in Wick in the year 1912. The first flock book was published in 1946.

It is important to realize that while there are now two breeds of Cheviot —commonly referred to as " North Country " and " Border " Cheviots— these two types are not by any means restricted to their districts of origin. Until quite recently there was an annual importation of " Border " Cheviot rams to the North Country. In recent years the tide has turned the other way, and North Country rams have gone in increasing numbers to the Border districts. Thus " two hundred and sixty-six North Country Cheviot rams were sold at Hawick Annual Ram Sale in 1945, as against only seventeen in 1936."*

There are now some excellent flocks of North Country Cheviots in the Borders, as shown by the fact that the Reserve Breed Champion at the 1948 Royal Show was bred near Hawick. Conversely, there are several stocks in Sutherland and Caithness that are definitely of Border type.

What then *is* the difference between North Country and Border Cheviots? —for there can be no doubt that they are distinct. Perhaps it is fairest, first of all, to quote the official descriptions as given by the respective breed societies.

(1) The Cheviot

Size. Medium.

Head. Broad between the eyes. Covered with white hair to meet the fleece. Black nose. Black eyes preferred. A broad crown well haired. Ears well haired and erect. A horned breed originally and horned rams are not uncommon.

Shoulders. Flat on top and descending to allow of the forelegs being well planted apart. Breast well in front of the forelegs.

* *N. C. Cheviot Sheep Soc. Flock Book,* Vol. 6, p. 5.

Back. Back should be level and broad with the backbone well covered.

Ribs. Round and well sprung as a sign of stamina.

Barrel. Ditto. Ditto.

Legs. Legs well covered with white hair and forelegs well set apart. Strong, flat bone. Correct in pasterns."

(*British Pure-Bred Sheep*, 1946, p. 18.)

(2) North Country Cheviot

Head and Face. White, well covered with fine hair, free from blueness or brown. Ears, of fair length and thickness, well covered with white hair, and coming out from the head at an angle of about forty-five degrees from the horizontal with good width between. Nose, straight to slightly Roman. Good width between eyes, broad muzzle, and wide, black nostril well open. Head, long, with deep underjaw. Eyes, dark, fairly big, bright and alert. Wool well up to back of cheeks and under throat and to back of ears but not between. The male is sometimes horned, but the horn must be free from blackness.

Neck. Strong, big at base, well set in at shoulders, and of medium length.

Breast. Deep and wide.

Body. Long, deep and wide. Back, straight with good width between shoulder blades and no falling off or slackness behind them. Belly and flanks well covered with wool. Ribs, well sprung. Tail, broad and well woolled.

Legs. White, of fair length, set well apart and coming down straight from the four corners of the body, with strong flat bone and well-defined hocks. Hooves, black and of good strength.

Wool. White, of good staple, free from curl, hair or kemp. Not hard, but has a springy feeling when grasped.

(*N. C. Chev. Sheep Soc. Flock Book*, Vol. 1, p. 14.)

North Country and Border Cheviots Compared

Flock book descriptions, while doubtless of service to breed judges, are not particularly informative to the general reader. I follow them, therefore, with what I consider to be the main differences between the Cheviot sheep and its North Country derivative. In doing so I must again emphasize that both my descriptions and views are purely personal and might well be contradicted by competent judges of either breed.

To me, the Cheviot is the most attractive and beautiful sheep breed of all. The keen expression, prominence of the eyes, sharp and erect ears at once attract attention. The whole bearing is vital, the body graceful and symmetrical.

In comparison, the North Country Cheviot is a heavy and plain-looking sheep. Superficially, at least, it is far closer to the Half-Bred (Border Leicester × Cheviot) in weight, shape, style and carriage, although no North Country breeder would admit to its containing Border Leicester blood, and indeed, the fact that North Country Cheviot wool is rather finer than that of the Cheviot is against such a hypothesis. The set of the ears—very different from that of the Cheviot—is sufficiently emphasized in the official description. The heavy face, slightly Roman nose, combined with the rather horizontal set of the ears, gives the sheep a somewhat lethargic expression. I don't think that even the most enthusiastic North Country breeder would contend that he breeds a bonnie sheep.

Yet, let it be admitted at once, the economical production of mutton and wool, not beauty, is the true function of sheep. Is then the North Country Cheviot the more useful ? There is evidence, at least under certain circumstances, that it is.

CHEVIOT SHEEP

For a long time now, certainly for many years previous to the foundation of the North Country Cheviot Sheep Society, the Cheviots from North Scotland have had a particularly good name. It is generally conceded that they are " sound " sheep, in the sense that they are free from most diseases that afflict the sheep, particularly from " scrapie," that curse of Scottish white-faced sheep. Again, one of the chief uses of the modern Cheviot is to breed the Scottish Half-Bred ewe when crossed with the Border Leicester, and it is generally, although by no means universally, admitted that the best half-bred sheep are bred out of North Country Cheviot ewes. As the result of a good deal of personal experience on this point, I am inclined to agree.

The fact that North Country Cheviot rams are being bought so extensively by Border sheep-breeders certainly suggests that the North Country breeders have succeeded in producing the better sheep. It is possible in this connection, however, that the fallacy that sent old James Robson of Bedford riding into Lincoln, may have again reared its seductive head. In this case the fallacy is especially liable to be overlooked, because sheep of such different size and type are all labelled Cheviots, and because the North Country Cheviot has been evolved in the most northerly quarter of a mountainous country.

Nevertheless, it is only fair to say that Caithness, the home of the North Country Cheviot, is not hill country. It is a bare and windswept plateau—hard country enough—but most of the land is flat, much of it cultivated, and some of it very good. It might be expected to produce a heavier and more productive sheep than the Border hills can ever hope to support.

Why then the interest of Border breeders in North Country sheep? Partly (although this would be denied by some) in a search for healthy sheep, because, for a variety of reasons, too many of the Border sheep stocks have become " unsound". Partly (although, again, this might be denied by many) because breeders of the fashionable strains of Border Cheviots may have concentrated too much in producing a stylish and attractive sheep without paying sufficient attention to the more important qualities of sheep—the qualities that pay rent. Some breeders of pedigreed strains of hill sheep by their absurdly artificial methods of ram rearing, their showyard fancies and their search for record prices, have much to answer for. Had all the sires of the Border Cheviot breed been bred, selected, and fed on the green slopes of the Cheviot hills themselves, the breeders of the North Country Cheviot might never have gained the opportunity to intrude.

Finally, it is always interesting to view one's country's livestock through the eyes of foreign observers. New Zealand, recently, has become interested in the Cheviot as an alternative to the Romney on her less fertile hill grazings, and various trials—in their results highly complimentary to the Cheviot—have been undertaken. New Zealand sheepmen, however, have been quick to realize that there are several types of Cheviot. They appear doubtful—as I am—whether the North Country Cheviot as bred in Caithness, although admittedly an excellent proposition for cultivated upland pastures, can be classed as a true hill sheep. For the fashionable type of Border Cheviot, best viewed at Hawick sales, they have but faint praise. Their preference—to judge from the Proceedings of the Tenth Annual Meeting of Sheep Farmers held at Massey Agricultural College in 1947—is for the Cheviot of the south-west Border country, with its sale centre at Lockerbie.

It may well be that the salvation of the genuine hill Cheviot, as of the genuine hill Blackface, will be found in the south-west district of Scotland—in the counties of Dumfries, Kirkcudbright, Wigton, and Ayr—where hill

farmers appear to have proved as loyal to the true characters of hill stock as their Covenanting ancesters, in historical times, proved so firmly faithful to a greater cause.

References

1. Youatt. " Sheep " (1864) 284.
2. The Cheviot Sheep Society Handbook, 11.
3. Wallace, R. *Farm Livestock of Great Britain,* Fifth Edition (1923) 590.
4. Wallace, R. *ibid.* 590.
5. North Country Cheviot Sheep Society Flock Book, **6**, 8.
6. Wallace, R. *ibid.* 592.
7. Wallace, R. *ibid.* 593.

KALE FOLDING WITH THE ELECTRIC FENCE

R. A. John
University of Reading

THE suitability of the kales as a winter fodder for dairy cattle has become firmly established, and for some time the portion of the rootbreak allotted to kale has been extended every year on many farms. More and more farmers are recognizing that in kale they have a main source of fresh green fodder in winter and a valuable source of protein. In favourable conditions kale can play in winter feeding much the same part as that of grass in summer ; it can save concentrates and, by its richness in carotene, maintain the colour of the milk during the winter months.

Marrowstem kale can stand until Christmas with little loss of feeding quality, and in the southern counties it can be fed until well into the New Year. Thousandhead kale is even more winter hardy and can be left for feeding to farm stock in late winter and spring. There need, therefore, be no lack of fresh green food from autumn to spring where it is possible to grow a suitable acreage of both kinds of kale, combined with a carefully arranged sowing programme.

The harvesting of kale is the biggest drawback to growing the crop. On the majority of farms where kale has to be cut and loaded by hand daily, the farmworkers will all agree that it is the worst winter job on the farm. Besides the distasteful nature of the task, it is very wasteful of labour and almost doubles the total cost of the crop.

Where a large acreage of kale is grown and over two tons are fed per day, mechanized methods of harvesting are possible. The ideal system, of course, for both the large and small farmer is the folding of kale by means of the electric fence. In this way *labour costs of feeding the crop can be reduced to less than £1 per acre.*

For certain success, a light, free-draining soil is essential, so that the land does not become unduly poached in wet weather. Also it is far more likely to succeed in the southern part of the country where the winter is milder and more open than in the north.

The feeding of the crop should begin when grass becomes scarce in the autumn, the time varying with the season; but earlier than is the general practice. Thus, where grass is scarce in September, kale should be fed to maintain milk yields, while in a season of ample autumn grass and aftermath feeding may be delayed until October or November. In sheltered areas the crop may be used throughout the winter and may even last until April.

Equipment Required The Reading University herd at Sonning was successfully folded on kale during the 1947-48 winter, using temporary electric fencing throughout.

A single wire, either plain or barbed, and sufficiently strong to withstand a moderate strain, is adequate. The height of the wire above the ground should be roughly two-thirds the height of the stock. Galvanized iron posts 2½ feet above the ground were used here; and this height should be regarded as a maximum, for there is much more likelihood of the stock pushing underneath the wire than jumping over the top. The insulators should be screwed into a clamp which can be moved up and down the posts, thus allowing for easy adjustment of the height of the wire. The posts should be inserted at intervals of not more than 8–10 yards. If the wire cannot be strained from a permanent hedge or fence, then a wire anchor can be attached to one of the galvanized iron posts. (An efficient straining apparatus on the tripod principle and easily erected in a few minutes has recently been designed by a leading manufacturer of electric fencing equipment.)

A suitable site for the actuating apparatus must be selected for ease of operating and inspection: also this should be well protected from the weather in a water-tight container. One of the most important points when setting up the apparatus is to provide a really good earth. A length of angle iron or piping driven into the soil at least 3 feet fulfils these requirements and in dry soils it is advisable to water around the earth pipe to ensure a good shock.

Too much stress cannot be placed upon the importance of good insulation, and this is much easier to achieve with the proper equipment. To prevent the kale plants shortening the wire it is necessary to chop out one row down which the fence is laid. It is also advisable to check up from time to time that no plants from adjoining rows have fallen across the wire. If the fence is shorted at any point the sting will be eliminated along its entire length and so fail in its purpose.

Training the Stock Respect for the fence right from the start is of the utmost importance, for it is not the wire that holds the stock back, but their fear of the sting they receive every time they touch it. No animal should be turned into the field until it has been properly trained. To do this, a piece of wire, preferably barbed, which gives a bigger sting, is stretched across one section of the field and electrified. Some tempting food is placed on the far side of the fence and the stock allowed to come to the fence slowly so that they learn the cause of the sting. After one or two attempts to reach the food they will realize that the sting comes from the wire. When the animals no longer attempt to reach the food they are properly trained and ready to be folded on the kale. Ten to twenty minutes is usually time enough to completely train a herd of cattle.

Lay-Out Recommended The factors to be taken into account in deciding the length of the fold are:

(i) The ease with which the fence can be moved each day, including chopping out a row.

(ii) The area of fold per cow required to prevent undue bullying and to ensure that each animal, including the heifers, obtains a fair share.

The second factor is the more important, for even with the longest fold used, the time required to move the fence by one man was just over an hour. Cutting and carting a similar amount (1¼ tons) would take the same man 7–8 hours.

From the experience gained at Sonning it would appear that 2½–3 yards of fence per cow is ample. These figures refer to horned cattle: with dehorned cattle probably 1-1½ yards per cow would suffice.

It has been suggested that to eliminate the work of cutting out a row, a variety of kale such as Hungry Gap, which grows only to a height of about 18 inches, should be planted every fourth or fifth drill. Alternatively, cabbages could be planted, with the added advantage that they could be sold as a cash crop if the demand arose.

Having estimated the length of fold required, a narrow roadway, say, 1-2 yards wide, should be cut across the kale and an electric fence erected as described above. It would be advisable, but not essential, to use barbed wire on this cross fence, since it is of a semi-permanent nature and may be down for 1–2 months. A roadway into the field could be cut for carting off in order to avoid wastage through trampling. Depending on the amount to be fed per head, and the estimated yield of the crop, the number of rows to be allowed per day is calculated and the cross wire laid down accordingly. If the cows have been thoroughly trained to respect an electric fence, the plain wire can be used, but if there is any doubt it may be better to use barbed wire for the first week or two. After that plain wire can be used; this cuts down the time required to move the fence and is equally efficient once the cows are properly trained.

Should one or two cows attempt to push underneath the wire, they may be prevented by suspending a wire loop or piece of chain round their necks and clipping away their hair. If a number of cows break through, then the wire may be lowered or, as a last resort, barbed wire may have to be used again.

From observations at Sonning, when up to 90 lb. of kale per head was offered to the cows, it would appear that 55-60 lb. is the maximum amount which a cow can comfortably consume at one meal and an approximate time to allow the cows would be two hours. The ideal system is to have a bare pasture adjacent to the field of kale, so that the cows can wander off when they have grazed it down; after that period, too, they require water.

Wastage A criticism which has been levelled at kale folding is that the wastage involved is much greater than cutting and carting. To obtain a rough estimate of the amount left by the cows after folding, areas of the folded portion at Sonning were selected at random immediately the cows had been brought off. The percentage wastage varied from 4 to 11 per cent, but these figures represent the maximum possible wastage, for a large proportion of the pieces of leaf and stem which were collected would probably have been consumed the following day. The major portion of wastage consisted of fibrous bits of stem; the weight of leaf was negligible.

Conclusions The main advantage of kale folding as compared with cutting and carting is the great saving in labour, as well as the elimination of what is probably the worst winter job on the farm. The cost of growing and utilizing the crop is almost halved when it is folded, and the cost of growing the other root crops cannot compare in this respect. Besides the great saving in labour and reduction in costs, the folding of cows on kale keeps the land in good heart.

KALE FOLDING WITH THE ELECTRIC FENCE

Reports from farmers in Gloucestershire show that there is some evidence to suggest that the health of the cow is improved. Where conditions permit this system offers attractive possibilities to the commercial dairy farmer in helping to reduce the cost of winter milk production. It is a logical method of winter feeding, combining cheapness with ease of working.

SELF-SUFFICIENCY IN HOLLAND, DENMARK AND SWEDEN

W. D. HAY

Mr. Hay spent between two and three weeks in Holland, Denmark and Sweden in June this year. The following article, which is based on his report, shows briefly the progress being made in those countries to grow and conserve their own protein for stock feeding.

ONE problem which Dutch, Danish, Swedish and British farmers have in common is the provision of home-grown fodder. Between the wars cheap, imported feedingstuffs were plentiful: now farmers must increase production with greatly reduced imports. In all three countries visited milk is produced from cows of a purely dairy breed, and the quality of the thousands of animals seen is very high. It is not surprising, therefore, to find that the average yield of these cows is some 100 to 200 gallons higher than our own. In Sweden 90 per cent of the milk is T.T., and Holland and Denmark are also producing a lot of T.T. milk.

Broadly speaking, farmers in Holland are making great strides towards self-sufficiency; they are producing very fine crops. In over 90 per cent of the country both arable and grassland look as if they are producing the largest economic yield possible. Dutch farmers are in a fair way to achieve the results, both from the land and livestock, which we hope to secure in England and Wales.

The grazing season in Holland is from the end of April to the end of October. Winters are more severe than in England and rainfall averages 22-30 inches, but a great deal of it falls during July and August. As in England, there is abundance of grass in May and the first half of June; in the second half of June and the first half of July there may be a sharp decline, but there is plenty again from the middle of July. Dr. 't Hart pointed out that in his latest researches he found that where there was high productivity in grassland the "peak" almost disappeared.

Another important aspect in grassland management is the application of NPK "little and often": a dressing of P and/or K every few years is frowned upon.

As regards nitrogen, Dr. Frankena, Chief Grassland Officer, Netherlands, speaking in Cheshire, said: "Repeated application of nitrogenous fertilizer is necessary. We estimate that 26-35 lb. of pure nitrogen (i.e., 1¼ to 1¾ cwt. sulphate of ammonia) per acre is required *after each grazing* to ensure a regular growth of grass." Speaking of grassland management, Dr. Frankena went on to say: "... A more even rate of growth can be obtained by cutting grass for silage or drying as early as May. The mown grassland at this time still profits from good weather conditions in May and June."

Dr. 't Hart told us that the best grassland yielded up to 6 tons of dry matter per acre, and for highest productivity per acre the following dressings are required—10 cwt. sulphate of ammonia, 300-400 lb. K_2O and 100 lb. P_2O_5; and that in Holland for 1947 the following were used:

	tons
K_2O	120,000
P_2O_5	100,000
N	100,000

In Denmark and Sweden production seemed to be very similar to that of England and Wales, taking into account the different types of soil, crops, and rainfall.

In Holland the most remarkable results were to be seen on the grassland, although the arable land was also of the same high standard.* Both the qualitative and quantitative yield of the grassland was very high—4 to 5 tons of dry matter per acre is quite common with a comparatively high crude protein content, due, it is believed, to the quick growth. This is all the more remarkable, as most of the grassland is old permanent pasture with meadow foxtail and smooth-stalked meadow grass predominant; there is very little clover. The explanation is obviously high fertility and high-class management, including liberal NPK applications. We calculated that the whole country received an average dressing of over 1 cwt. per acre of nitrogen; phosphate and potash in proper ratio. Annual dressings of the basic manures are favoured. As an example, on one holding of 45 acres there were 27 cows giving an average yield of 820 gallons, with 20 followers, two horses, and a small number of pigs and poultry; 22 acres were cut for hay, 5 acres for silage, and a few acres for dried grass.

It is estimated that 10-15 per cent of the farmers use such quantities, and 50-60 per cent use half the above quantity per acre; only a few use no nitrogen at all.

Food for winter on this farm was: 40-50 tons hay, 60 tons silage, 5 tons dried grass, a quantity of wet grains, and 330 lb. concentrates per cow. This particular farmer was folding his grassland by electric fence, a practice which is becoming more popular.

The above was not an exceptional case; just an ordinary keen and intelligent young farmer, interested in his job and doing his best for his country *and himself*. From my experience driving through the country I should say that the majority of farmers are farming on the above scale (note the proportion of silage and dried grass), bearing out what was continually stressed—that silage and dried grass are complementary.

Haymaking Many farmers make hay by tripod or ordinary cocks, but there is not necessarily a lesson here for the English farmer, as the acreage is small and the farms are not mechanized to the same extent as in England. Hay yields in Holland must be at least 2 tons per acre on the average, probably more, and as the hay is well made this makes an extremely valuable winter feed.

In Holland and Denmark tripods and cocks are widely used; in Sweden there are few tripods and cocks—the majority use the rack, i.e., three wires strung on poles over which the grass is hung. Farmers are also being exhorted to cut their hay earlier and are responding to a certain extent. In all three countries farmers object to heat in hay or silage; they say there is too much waste. The hay is not put on the tripod or rack until partly dry—probably

* Admittedly we did not see the whole of Holland, and recently reclaimed holdings are excluded from this report.

a couple of days before it would normally be carried in England. This means that it is fairly green and, in good weather, may be put up within 24, or at the most 36, hours after cutting.

Silage-making A large proportion of the farmers in Holland, Denmark and Sweden are equipped with tower or concrete silos, often partly sunk in the ground. The A.I.V. method* is universal, although the use of molasses is favoured in many parts of Holland. In Sweden molasses is not available. One of the greatest authorities in Sweden said he would prefer molassed silage to the A.I.V. if they could get molasses. Neither in Sweden nor in Denmark was the adoption of ensilage as general as expected. All kinds of propaganda are used, but many of the farmers are, we were told, very conservative. (I seem to have heard this before somewhere !)

We were particularly struck by the research work on silage-making going on at Uppsala and the facilities available for this work.† At Ultana we saw in one building room for a large herd of cows, feedingstuffs, threshing outfit, hay and straw barn, and at least six silos, two of them large. It is quite general on farms to have silos inside barns—a very necessary precaution in view of the hard frosts.

In Holland 70 per cent of the farmers, and in Denmark 20 per cent, are making silage. In Sweden the proportion is not so high. All advisers are, however, advocating silage-making, just as we are in this country. A great deal of autumn silage is made, and in Denmark potato silage was being fed with the early spring grass to balance the protein

Dr. Frens advised 4 per cent molasses (90 lb. per ton) for complete conservation ; usual crude protein in silage (dry matter) around 18 per cent ; he also suggested that dried grass should be fed long, as quality cannot be assessed as meal (the meal is always soaked before feeding). Dr. Frens also pointed out that autumn grass is not as good as spring grass, either dried or as silage, and he does not think it possible to feed high-yielding cows entirely on hay, silage and dried grass ; 10 lb. of dried grass per day is enough.

In Sweden many farmers say, " No more hay, all silage." Here the " American " method of silage-making, i.e., using cold wilted material, chopped and ensiled without adding a preservative. The results are excellent and wastage was not above 4 per cent.

Dr. Jarl, Sweden, stated, however, that only 3 per cent of harvested green fodder is made into silage. Dr. Gobel believes that making silage is important to level the labour peak.

Lucerne There were some very fine crops of lucerne, the growing of which is encouraged. The importance of this crop is clear when it is realized that the rainfall in the farming areas we visited ranges from 19-24 inches in Sweden to 22-30 inches in Holland and Denmark. In most cases lucerne is grown pure, with a seeding up to 30 lb. per acre, but a few fields were seen with timothy as companion. Canadian Grimm seemed to be the favoured variety. Manuring and management are similar to our own.

---

* 8 kg. A.I.V. to 100 kg. greenstuff (diluted 1 to 6) ; a little more for lucerne and clover.

† Experiments are being carried out on the making of silage with molasses A.I.V., formic acid, ground oats, whey, etc. Swedish farmers use approximately twice the amount of molasses advised in England.

Grassland Taking the three countries as a whole, there are practically no three-year leys. In Holland, permanent pastures predominate, whereas in Denmark and Sweden the one- and two-year ley, based on red clover, are universal. In many parts difficulty in establishing white clover may be one of the reasons.

In Denmark and Sweden dandelions are profuse in many of the leys. In Holland, however, all the grassland is highly productive. There is an absence of clover and, as already stated, meadow foxtail and smooth-stalked meadow grass are much in evidence. High productivity is due mainly to high fertility and first-class management.

The great importance attached to grassland is evident from the fact that experiments are being carried out in both Holland and Sweden on the artificial irrigation of pastures. Sprinklers, driven by a small petrol engine, are used. Great care is taken to see that there is no wastage of animal manure, and liquid is saved and sprayed on the fields on many farms. It was pointed out that only on very productive grassland is protein high.

Feeding Dairy Cows In Holland silage figures largely in the cows' diet; all sorts of silage—grass, lucerne, potato, sugar-beet tops (where grown), and silage made from bulbs. Wet grains are also used where available. Concentrated foods are scarce, and a definite quantity is supplied per cow, but not related to milk yield, as in this country. (As practically all cows give a reasonable milk yield, this seems a good method.)

Winter feed for a four-to five-gallon cow is:

	lb.		*lb.*
Concentrates	6	Hay	12
Hay	13–14	Silage	50–55
Wet grains	20	Dried grass	16–18
Tulip bulb silage plus minerals	18		

Winter feeding in Denmark and Sweden is similar with variations due to district, sugar-beet pulp being available is some districts, whereas wet grains are not. Hay is fed in all countries.

Great interest is being shown in dried grass. As in Britain farmers in Holland, Sweden and Denmark are feeling their way with great hope that dried grass will help to solve the " high protein " question.

In Denmark, in particular, the tethering of cows is very common. Farmers seem to be very keen on the proper utilization of grass and, as in Holland, the electric fence is becoming more popular. Fodder beets are common to all countries, but the growing of mangolds has more or less been given up.

COMBINE HARVESTING IN NORTH WALES

G. M. Davies, B.Sc.
University College of North Wales, Bangor

ONE of the distinctive features of the farming economy of the counties of Anglesey, Caernarvon, Denbigh and Flint, is the importance of livestock. The arable crops grown are chiefly those required to satisfy the needs of livestock during the winter months. Great reliance, therefore, is placed on roots, and oats is easily the most important of the cereals—relatively little attention is given to wheat and barley. Another feature of farms in the four North Wales counties is the smallness of the farming unit. One-half of them are between 5 and 25 acres, and only one farm—or rather less than one farm—in every hundred is over 300 acres.

It is not surprising, therefore, that the combine harvester, which has made such rapid strides in parts of England and Scotland during recent years, has made little headway in North Wales. The size of farm and the system of cropping are not conducive to its introduction.

During the 1947 harvest more than 4,000 combine harvesters operated in England and Wales, but the number in North Wales for the same year was no more than seven—five in Anglesey, one in Caernarvon, and one in Denbigh.

Information is available concerning six of these machines, but detailed data are available for only three machines. The first combine harvester was introduced in 1940. Three more started work in 1944, and the remaining three were purchased in 1945, 1946 and 1947.

The most important reason advanced for buying combine harvesters was that of rising labour costs, coupled with the difficulty of obtaining satisfactory labour on some of the more remote farms. One farmer gave as his main reason the difficulty of obtaining satisfactory casual labour for the threshing. It is perhaps worth while recording that all combine owners, or at least one member of their family, seemed to have a natural aptitude for machinery and had mastered to their own satisfaction the intricacies of the machines. Not one combine user expressed the view that combine harvesting reduced costs, but there was a suggestion that the investment of war-time profits on such a machine was a wise provision against any further rise in labour costs.

Type of Combine Four of the machines had cutter-bars of 12 feet width—comprising Massey-Harris (three) and International (one). Of the other two machines, one was a Massey-Harris 8 feet and the other an Allis-Chalmers 3½ feet. During 1947 the six combines harvested the acreages shown in the following table.

Type of Combine and Acreages Cut during 1947

Farm No.	Combine	Wheat *acres*	Oats *acres*	Barley *acres*
1	Massey-Harris 12 ft.	58	109	80
2	Massey-Harris 12 ft.	—	40	97
3	International 12 ft.	—	63	—
4	Massey-Harris 12 ft.	30	35	130
5	Allis-Chalmers 3½ ft.	22	7	—
6	Massey-Harris 8 ft.	—	80	—
	Total	110	334	307

Included in the above figures is a fair amount of contract acreage. In all, three of the combines cut a total of 221 acres for neighbouring farms—78 acres of wheat, 68 acres of barley and 75 acres of oats—which represents

between 29 and 30 per cent of the total acreage combined. The number of acres cut per foot of cutter-bar is considered to be a factor of some importance in the economics of combine harvesting. In this connection figures of 20–30 acres per foot of cutter-bar are quoted as being within the reach of such machines. However, the total area cut by the six harvesters represents only approximately 12½ acres, ranging from 20½ acres on Farm No. 1 to as low as 5¼ acres per foot of cutter-bar on Farm No. 3. It would seem, therefore, that with the exception of that on Farm No. 1, all the machines were working to varying degrees below their potential and that a saving might have been made if 8-foot machines had been bought instead of 12-foot harvesters. Depreciation is always the largest single item in combine harvesting costs, and when a high-priced machine harvests an acreage well below its potential, then this charge is correspondingly increased.

There is, however, an additional factor to be considered in discussing the size of the machine in relation to the area harvested, namely, that only on one of the farms has a grain drier been installed. The lack of drying facilities makes it absolutely essential that crops should be harvested in as dry a state as possible. It is not always easy to do this in an area where the rainfall is of the order of 40 to 45 inches, and it is of great importance, therefore, that the maximum acreage should be handled during suitable weather. At times, combine weather may perhaps amount only to a few hours at a stretch, and it is then that a large machine shows to advantage.

Varieties Abed Kenia was the only barley variety combined. Farmers have been quick to appreciate the merits of this short-strawed variety. One grower stressed the importance of pure stocks of seed; apparently he had purchased what purported to be Abed Kenia, yet at harvest time at least one other later ripening variety was present, and this caused a good deal of trouble. An analysis of oat varieties showed that Golden Rain, with 153 acres, was easily the most popular. This oat is specially favoured by Anglesey farmers. The remaining area was covered by 87 acres of Star, 63 acres of Victory, 27 acres of S.84, and 5 acres of Onward.

Lodging was mentioned as a difficulty with oats, and at least one combine user is hoping to try the short-strawed S.225 variety in the future. Rather more than one-half of the wheat combined was Atle, with small acreages of Fylgia, Holdfast, and Red Marvel.

Costs Three farmers provided data sufficiently detailed to enable the costs of combine harvesting to be studied. One of the machines cut an acreage in keeping with what is expected under average conditions, but another—a 12-foot machine—harvested only 63 acres. As might be expected, there was a big discrepancy in costs due to the latter machine operating well below its potential. On this farm the costs were about £1 10s. an acre higher. However, costs are not the only criterion in assessing a venture of this kind, and especially is this true on an outlying farm, where labour is difficult to obtain. Indeed, in an extreme case, the introduction of such a machine might be the only way of carrying on production with any degree of efficiency.

Drying One important question is whether combining can be carried on successfully without a drier. This is doubtful—especially when one considers the high proportion of oats harvested, and here again there is the additional factor that much of the oat crop in North Wales is undersown, which adds to harvesting difficulties. It is perhaps significant that a good proportion of the oat crop is sold immediately it has been harvested, which

seems to suggest a lack of confidence in the keeping quality of the sample. An attempt to grapple with the problem has been made by one farmer, who has concreted all available floor space. It is hoped to spread out the grain fairly thinly and to get about one-half dried in this way. The amount of grain grown on individual farms hardly seems to justify the expense of a drier, but under North Wales conditions—especially in the west—combining without a drier seems a hazardous proposition. Possibly the solution may be in the direction of communal driers or a grass and grain drier.

Lastly, there is the problem of dealing with the straw. Oat straw is a very valuable feed on Welsh farms, and combined straw is inferior to oat straw harvested by the binder. On three of the farms, one-man pick-up balers were used with great success, and users are confident that this is the solution to the problem.

WINTER WORK IN THE FARM ORCHARD

RAYMOND BUSH

GOOD fruit is still at war-time prices, and orchard trees are profitable when they are looked after. It is always a pleasure to see a well-kept and fruitful farm orchard, but too often that side of the business is a doubtful asset, save in the so-called "lucky" years. Last year was a "lucky" year simply because we had no frosts in April and May when the fruit blossom was out. As a result almost every bloom set and a very heavy crop matured. The summer, too, was fine and so Apple and Pear Scab failed to come along and mark the fruit. Brown Rot did not worry the plums or cherries, and there was little fruit splitting. In most farm orchards there was a good surplus of fruit even when the caterpillars and other pests had finished plaguing the trees. 1948 is *not* a lucky year, and crops will not be as good as those of 1947.

Frost Frosts and pests are fairly regular visitors, but much can be done to prevent, or at least reduce, damage by both. Let us take a look at frost first.

Many a farm orchard has high hedges which have been allowed to grow up almost as tall as the trees themselves. If the orchard happens to be on land that has a fall to lower ground, then on a cold spring night frosty air will be flowing over or through it. Then a tall hedge which is set across the line of fall may easily cause the cold air to back up behind it, thus involving a part or all of the orchard. Frost damage occurs because on calm, clear nights in spring everything exposed to the night sky loses heat and chills the air in contact with such exposed surfaces. This cold air collects and soon begins to slide off the hillsides and slopes down into the valleys and plains below. If you think of cold air as cold water you will realize just how it will run and collect in the dips and hollows and pile up behind hedges or where big coppices block a valley bottom. In the orchard on a gentle slope the level

of the top of the hedge on the lower end of the orchard will often decide the level to which frost damage will occur. Lower the hedge and frost damage will fall accordingly. Commercial growers now deal drastically with such barriers to air drainage. Shelter is a fine thing on a windy day so long as the hedge follows the line of land fall, but only then. A close-grazed orchard is also warmer on a frosty night in spring than an orchard deep in docks and nettles.

Caterpillars This has been a very bad year for caterpillar damage. Many a garden and orchard has been defoliated. I have heard farmers say: "Well, after a big crop last year the trees need a rest." That is not good reasoning, for it is not rest for a tree to have to grow two crops of leaf in a year because the caterpillars have eaten the first. The sort of rest a tree needs is one which allows it to grow a full crop of fine leaf so that big stores of reserve food can be made by those leaves and packed away within the tree for the coming season's crop. Given good leaf one year, and a moderate or no crop of fruit, you may expect a bumper crop next year.

Spraying Spraying is a nuisance to the man who has never done any or has half-heartedly applied an inadequate washing. Once its good results are appreciated, it is seldom omitted in routine orchard operations; but a great deal of early caterpillar damage can be prevented by stopping the moths which lay the eggs from getting up the trees. Although I recommend spraying to every man who has a good orchard, I do not propose to explore the subject now but to discuss the merits of grease-banding.

Grease-banding To the general public a moth is just a nuisance which flies around the lamp or eats holes in one's best suit. There are a great many pestiferous varieties of moth doing active damage at various times of the year. The codling moth, which holes the apples in late summer, is a very serious pest, but it is likely that on the farm orchard the caterpillars of the winter moth are the worst offenders. Winter moth caterpillars hatch very early and are at work long before leaf is visible.

Only the male moth can fly; the female moth, being wingless, has to crawl laboriously from the soil up the tree stem and along to the fruit spurs and twigs to lay her eggs. Each moth carries hundreds of such eggs. She can be caught with her burden of eggs on a sticky band laid around the tree trunk.

In the old days cart grease was occasionally used on farms to smear round the tree trunks. This soon set hard and also damaged the bark. A good modern tree-grease will not set hard in a season and remains sticky. It will not injure if applied direct to the bark of any tree over three years old. There are several good brands of tree-grease, and at least one very bad one. The good ones are expensive but the useless one is dear at any price. Before buying ask any fruit grower who bands his trees for the name of a good grease.

Let us suppose that you have decided to grease-band your trees at the end of September and have paid out what seems to be a high price for a 28-lb. bucket of grease. There is no advantage in tying paper bands round the trees and spreading the grease on these unless you feel that an artistic effect results. Very often tits and other insect-loving birds will rip and tear the paper bands to pieces to get at the grubs and weevils and caterpillars which have crawled underneath the bands to spend a warmer winter.

If the tree is old and the bark rough and loose it should be prepared to take the grease applied direct to its surface. To clear off the old bark at the

spot where the grease is to go, make a scrubber by rolling up some chicken wire into a tight ball and scrub hard all around the stem. To apply the grease, which runs best on a warm, sunny day, use either the hand, or if you are fastidious, cut a wood paddle about 3 inches across and smear it on with that, applying the grease thickly enough to make a continuous band, but not so thickly that it runs down. If the weather is cold keep the grease in a warm corner by the stove until you want to use it. If used by hand it can be removed at the end of the day with paraffin and a little sand or soil used as an abrasive.

Before November is out you should be able to find plenty of wingless female moths looking like small grubs stuck on the lower levels of the grease. There will also be male moths with outstretched wings who have got caught in trying to find out what has delayed the girl friends. Press one of the freshly caught female moths with a finger and a mass of eggs will be exuded. But for the grease-band, these would have been caterpillars by early spring.

Pruning Winter is a good time to prune mature or old trees, though it can be begun as soon as the crop is off and before leaf fall. Where no special attention has been paid to farm orchards it is usual to find the trees far too overcrowded with branches, or even growing into each other.

There are various ways of pruning a tree but they all rely on letting in enough vital daylight to mature leaves on the bearing wood and the new growths, so that these leaves can manufacture foodstuffs to start spring growth, and mature a fruit crop in the following season. Sunlight and daylight are absolutely essential for fruit production.

Very often trees are far too closely planted when the orchard is laid out, and when the trees touch each other branches begin to die. Branches which overlay each other cause the death of the branch below, and farm trees are often full of dead wood in the centre. If the orchard has been planted on the square system at 12 feet apart both ways, or at 18 feet, or whatever it may be, then thinning out is a simple matter. One simply removes the diagonal rows of trees. Tops of condemned trees should be cut off first and dragged out of the orchard and the tree-trunks can then be pulled out by a winch or by a high-power tracklaying tractor or even a wheel-type tractor, according to the size of the tree and the consistency of the soil.

Such orchard thinning will begin to show its effect in a couple of years, and need not lower the cropping ability for more than three years, while much improving size and quality. The grass below the trees will improve very quickly, resulting in better feed for animals grazing the orchard. For really poor orchards the folding of poultry in movable arks adds very valuable manure to the grass. However this is achieved, better grass means more food and more nourishment for the trees.

Grafting Preparations can soon be made for grafting over unprofitable varieties of apple or pear to those in market demand. Grafting is not a difficult job to do once the principles are learned; any man of average intelligence, who is handy with his fingers, can soon be taught. Once learned, the art is never forgotten and will always remain an interesting and profitable accomplishment.

Young wood of the varieties intended to be used for grafting together with the wax for covering over the point of union, should be obtained in the autumn. The old "pug" or clay can be made when work begins and used if preferred, but consisting as it does of clay, fresh cow-manure and chopped hay, its popularity among workers is not on the increase.

Probably Laxton's Superb for dessert and Bramley's Seedling for cookers are still the best apples to work, but the latter makes a very strong tree and needs plenty of room.

Protection Replacing dead trees or gaps in an old orchard is seldom profitable, and it is essential to protect young trees so planted against rabbits, sheep, and cows. Even a goose can bark a young tree fatally. Cows in orchards will always graze off the drooping branches as far as they can reach to above head level, and a particularly intelligent specimen will stand on her hind legs and pull down branches which one hoped were far out of reach.

Post-Winter Precautions Grease-bands cannot give full protection against caterpillars and there are also several other serious pests which are liable to build up in orchards where no precautions are taken. The apple blossom weevil is such a pest and causes the blossom buds to dry up and fail to open. A few years back we had no effective control for this pest, but today we know that a single spray with DDT, as the buds begin to show the green, will give almost full control.

Greenfly on plums and other fruits can be very damaging and may cause a complete crop failure, yet the eggs can be killed in winter by a single application of tar-oil spray.

Fungus pests, such as Scab and Brown Rot, can ruin a fruit crop in wet districts, or in wet seasons, but the former at least can be reduced substantially by spraying at the right time.

Modern commercial spraying machines and equipment are expensive and need skilled care and maintenance. Because of this the farmer's best course is to arrange either with his local Agricultural Executive Committee for a visit or two by the county spraying gang or with a spraying contractor. If a pest-ridden orchard is cleaned up the returns in fruit will show a very handsome profit.

Management It is preferable never to take a crop of hay from below fruit trees. Unless under cultivation an orchard should be grazed close and any manuring calculated to improve the feed will help the trees by increasing the supply of dung. Modern fruit growers are now seeding down hundreds of acres of fruit to be gang-mowed to the closeness of a lawn. Experience of the past few years suggests that grass cut close at frequent intervals, and allowed to rot down, takes little if anything out of the soil, and if the mixture is well up in white clover, gives a satisfactory supply of nitrogen. In drought times the gang-mowed orchards suffered less from drought than those clean cultivated.

Cider Fruit In addition to dessert and cooking apples, there is a useful demand for cider apples of the right varieties. There are in the West of England alone nearly 60,000 acres of farm and cider orcharding, with an average yield of barely a ton of fruit to the acre. The season's cider price has been agreed at £13 a ton. There are possibilities in planting fresh acreages to cider, especially in areas where soil is suitable but frost is damaging. Some of the best types in present demand flower so late that they miss the frost. Trials at Burghill, in Herefordshire (fully reported in the *Herefordshire Agricultural Journal*, issued by the Herefordshire Agricultural Executive Committee, price 2s.) show that one favoured variety of cider apple, Yarlington Mill, averaged 8 tons 16 cwt. to the acre over a period of years, which at last year's price was equivalent to £123 an acre. Cider orchard planting is worth looking into. Using modern methods and with the right trees, the farmer can plant for his own profit and no longer need regard a cider orchard as a legacy for his grandchildren.

PREVENTION OF EXCESSIVE SPROUTING IN LATE-STORED WARE POTATOES

A. R. WILSON, PH.D. and R. K. MCKEE, M.A.
Agricultural Research Council

WASTAGE in clamped potatoes, apart from losses due to mechanical injury and certain growth deformations, can be divided roughly into two main categories, "pathological" and "natural". The former category includes direct losses due to disease and insect attack and physiological breakdown caused by faulty storage conditions—all types of wastage which can, to a large extent, be prevented by applying known measures of control of the diseases and pests involved and by the proper siting and construction of clamps. The latter category comprises loss of weight due to the natural life processes of the tubers: respiration, loss of water, and sprouting. Pathological wastage, where present, is usually obvious and its extent can readily be determined. For this reason and because individual losses may be high, it is apt to receive most attention, notwithstanding the fact that in many seasons the majority of clamps may be little affected. Natural wastage, on the other hand, because it is difficult to assess and its extent often not recognized, receives less attention than it deserves in view of the fact that it occurs to a greater or less extent in all clamps every year. It is, therefore, important to examine any possible method of reducing it.

Losses in weight due to respiration, loss of water and sprouting are collectively known as "shrinkage". Respiration causes a relatively small proportion of the total shrinkage and can, for practical purposes, be ignored. Loss of water occurs firstly through wounds received during harvesting, until such time as these have healed, secondly through the lenticels or breathing pores of the tubers, and thirdly through the sprouts, the last-named being, in the later months of storage, by far the most important. Sprouting causes shrinkage in two ways: firstly by removing stored food material from the tubers, and secondly, as indicated above, by increasing water loss. It is apparent, therefore, that any method of control of sprouting will have a dual effect in reducing shrinkage.

Wastage due to Sprouting The extent of loss attributable to sprouting is extremely variable, for it is dependent on variety, locality, and season. As there is relatively little published information on the subject, some figures obtained from observations made in the 1943-44 season on three clamps, one each of three maincrop varieties, Arran Peak, Majestic and King Edward, may be of interest. The clamps used were divided into weighed sections of one ton when constructed and sections were opened monthly for weighing. The figures obtained are given in Table 1.

Table 1

Progressive Loss of Weight during Storage expressed as percentage of the Original Weight Clamped
(Mean of three clamps)

	Feb. *per cent*	Mar. *per cent*	April *per cent*	May *per cent*	June *per cent*
Weight of sprouts	0.4	0.9	2.2	4.3	6.0
Loss due to respiration and loss of water	5.0	5.8	6.3	9.2	10.3
Total Shrinkage..	5.4	6.7	8.5	13.5	16.3

It is evident that a rapid increase in shrinkage occurred as sprouting became pronounced and that the losses were considerable by May and June.

Figures of this type will naturally vary from season to season and according to the method of storage ; also in any year the figures for precocious and shy sprouting varieties will generally be greater and less respectively than the mean figures for that year.

Methods of Controlling Sprouting After an initial period the breaking of dormancy in potato tubers is largely a question of the temperature of storage. At 38°F. tubers will remain dormant almost indefinitely, at 40°F. the eyes will open but sprouts will not develop, at 42°F. sprouts will develop slowly after several months. At higher storage temperatures the period of dormancy is correspondingly decreased and the rate of sprout growth increased. Excessive sprouting in late spring could, therefore, be controlled by keeping the temperature of storage down. Unfortunately, the mean storage temperature in clamps cannot be kept below the mean air temperature ; in practice it is usually a few degrees higher, owing to absorption of radiation and restricted ventilation. Stripping the soil casing from clamps in late spring may reduce temperature and thereby sprouting, but observations made on pairs of clamps, one of each of which had been stripped, showed that total shrinkage was often increased by the stripping, owing presumably to the larger flow of dry air through the potatoes. For example, in May, in a clamp of Arran Peak which had been stripped at the beginning of April, the figures for weight of sprouts and total shrinkage, expressed as a percentage of the original weight clamped, were respectively 4.4 and 21.3, compared with 6.4 and 15.9 in the second clamp where the soil casing had been left intact. With clamp storage we must obviously look to means other than temperature control to reduce sprouting. In well-insulated permanent stores, on the other hand, it may prove possible to achieve some measure of success in this direction by night ventilation, i.e., by cooling the store and tubers by forced draught ventilation during the coldest period of the twenty-four hours, the lower temperature achieved being held for some time against the warm day temperature by virtue of the insulation.

Before passing to the consideration of chemical methods of control, it may be as well to make the obvious point that it is preferable not to retain precocious sprouting varieties for late storage.

Experience with Mana During the past ten years considerable experimental work has been carried out, particularly in the United States ([1,3]) and Holland ([4]), in the use of chemicals for depressing sprouting in stored potatoes. Of the compounds tested, the most effective has proved to be methyl alpha naphthalene acetate, which will be referred to hereafter as MANA. The results obtained have been very variable but, in general, more consistently satisfactory where tubers were stored in small bulk under conditions of restricted ventilation. Consideration of the data available shows that the treatment of potatoes in sacks or crates in spring with MANA at the rate of ½-1 oz. per ton, applied on a suitable carrier, is likely to prove of value to anyone sorting small quantities. Evidence of the value of treating potatoes in clamps or other forms of bulk storage where treatment must normally be applied in autumn, is, however, less definite. In Holland the best results obtained have been when the chemical was applied at the turning over of the clamps in spring—a procedure that is unlikely to be adopted on any appreciable scale in this country.

Previous work in England had not been extensive. In 1946 Wilson (unpublished) found that clamped Majestic, turned over in February and

treated with 1.4 oz. MANA in 20 lb. kaolin per ton, showed at the end of May 1.06 per cent sprouting on a fresh weight basis, compared with 1.44 per cent in untreated controls. No significant difference in total shrinkage was apparent. In 1946 Luckwill (2), using the same variety but with an application of only ½ oz. MANA in 5 lb. talc per ton, reduced sprouting from 5.09 per cent to 2.41 per cent after storage in clamp from late March to late June. No figures for total shrinkage were given in this experiment.

PETERBOROUGH EXPERIMENT, 1947 The value of any chemical treatment which would provide a marked degree of sprout depression in ware potatoes stored in bulk is unquestionable. As so little information was available in this country, it was decided to carry out in 1947 some tests with MANA applied as a dust at the time of clamping in October. The variety used was King Edward. Paired 5-ton clamps were constructed, one for opening in late March and the other for opening in May. The dust used was 2 per cent MANA on gypsum ; this was applied at the rate of 5 lb. per ton, giving a dosage of 1.6 oz. per ton, compared with the autumn treatment level recommended in Holland of 1.1 oz. and in the United States of 1.3 oz. For the purposes of the experiment tubers were weighed into sacks in the field and dusted by hand as they were tipped into the clamp. Under normal conditions hand dusting can be carried out as the picking baskets are tipped into the cart on the field.

The effect of the treatment on sprouting is shown in Table 2.

Table 2

Effect of Treating Clamped King Edward Potatoes in October with MANA at the rate of 1.6 oz. per ton. Sprout weight expressed as percentage of Original Weight Clamped

	March 23	May 11
	per cent	*per cent*
Treated	0.3	0.9
Untreated	1.0	1.8

Parallel experiments on tubers stored in bins in a building and in clamps sheathed with bitumen-impregnated paper to reduce ventilation yielded substantially similar results. Higher rates of application of MANA (3.2 oz. per ton) did not greatly improve the effect.

The extent of sprouting, even of the untreated potatoes, was never great, and the tubers remained very firm throughout. In March the treated potatoes would not, under commercial conditions, have required hand de-sprouting on the riddle, whereas this would have been necessary in the case of the untreated lot. In May the average length of sprouts in the treated and untreated clamps was approximately 1 inch and 3 inches respectively : considerably longer sprouts were, of course, present along the ridge and on the sides, these being more abundant in the untreated clamp (see illustrations on p. ii of art inset). At this time a certain amount of hand de-sprouting would have been necessary in both the treated and untreated lots, but output from the riddle was considerably higher in the case of the treated tubers.

Comprehensive cooking tests on samples taken both in March and May showed no deleterious effect of treatment on quality. Treatment with MANA is not considered in either Holland or the U.S.A. to render the tubers in any way unsuitable for human consumption.

The prevention of excessive sprouting may save money in two ways : first, by increasing the weight of sound tubers recovered by decreasing shrinkage and, second, by increasing the output per man-hour on the riddle

by reducing the amount of hand de-sprouting necessary. In the experiment we have described, reduction of shrinkage was negligible, as sprouting was not very marked, and the increased output over the riddles could not be measured, owing to the periodic stoppages necessary for weighing. However, the increased output over the riddle is not likely to have been substantial enough to cover the cost of the dust applied. The dust used in the experiment was prepared specially and the cost was 16s. per ton for the application of 1.6 oz.—a figure approximating to the cost of American proprietary compounds applied at an equivalent level.

Further Experimental Work Required

Although in this particular experiment it is doubtful whether any financial saving was effected by treatment, it is quite possible that a useful return might have been obtained if the amount of sprouting had been greater. There was a marked reduction in sprouting in the treated clamps, but, as will be evident from the photographs, the sprouting was by no means "prevented". It seems clear that the use of MANA dust is not likely to be an economic proposition in this country at present, when applied to clamps in the autumn, unless the potatoes are to be kept fairly late and sprouting is likely to be severe. Even under these conditions the degree of saving to be expected has not yet been determined. Obviously further experiments will have to be carried out, using several varieties in a number of localities, before it will be possible to say whether and under what conditions the dust may be expected to prove of value.

We are indebted to Mr. H. C. Tinsley of West Deeping, Peterborough, for placing at our disposal the facilities for carrying out the experiment described ; also to the Ministry of Food, Scientific Advisers' Division, for carrying out the cooking tests.

References

1. DAINES, R. H. and CAMPBELL, J. C. Potato sprouting inhibited by the use of alpha naphthaleneacetic methyl ester. *Amer. Potato Journ.* (1946) **23**.

2. LUCKWILL, L. C. The use of growth substances to inhibit the sprouting of potatoes in storage. *Ann. Rep. Agric. and Hort. Res. Sta. Long Asthon* (1946).

3. THOMAS, J. E. and RIKER, A. J. Sprouting of potatoes inhibited by plant hormones. *Amer. Potato Journ.* (1945) **22**.

4. VAN HIELE, T., VAN STUIVENBERG, J. H. M. and VELDSTRA, H. Onderzoekingen inzake de toepassing van conserveermiddelen bij de bewaring van aardappelen. *Meded. Inst. onderzoek op het gebied van verwerking van fruit en groenten te Wageningen*, 1946. Series 1, No. 16.

PHOTOGRAPHY IN AGRICULTURAL EXPERIMENTS

H. J. Hine, B.Sc. (Oxon.)
Ministry of Agriculture and Fisheries

PHOTOGRAPHY as an aid to experimental and statistical work can be as interesting and useful to a farmer as it is to a professional research worker. In this article I have endeavoured to indicate some applications and also describe some adaptations of apparatus to avoid buying expensive equipment. Pictorial records of, for example, an especially abundant harvest, or of the arrangement of implements to meet some special emergency, may provide help and encouragement in seasons to come; but most of the examples given here are of photography used deliberately to trace the progress of experiments.

One of the earliest uses of photography in this way was the recording of plant growth. When plants are to be photographed either in the field or in a culture pot, a calibrated rule should be placed in the main plane of the object. Then whatever the size of the photograph—or a reproduction made from it—the actual size of the object is readily gauged.

When a small shoot or sprouting seed is to be photographed it is sometimes better to support it on a piece of glass and take it from above, rather than fasten it to a vertical opaque surface. In this way no shadow is cast on to the background, and the detail in shadow on the plant itself is given more light. In the photograph the plant will appear isolated.

The glass, which must be clean, should be fixed on to a support made of wire bent to form a table, and a piece of grey or yellow paper placed beneath it to provide a neutral background. Care must also be taken to see that the glass casts no reflection into the lens of the camera. An upright stand fitted with a tripod screw to hold the camera and a movable shelf is convenient for this work.

Photographs of apparatus, used to illustrate a notebook, will recall to mind the arrangement of the instruments better than a complicated drawing requiring much time and skill. They can also be used instead of, or to supplement, tables of reference. As an example of this use an instance in tractor research may be quoted. In some work on the grip of driving wheels in various types and conditions of soil it was necessary to make trials with various, but known, back axle weights. It would have been difficult to bring the tractor in from the field to a weighbridge every time the back axle weight was to be changed. Therefore, some equal rectangular iron weights were cast in a shape to fit on the platform of the tractor. The tractor was placed with both rear wheels resting on a weighbridge, weights added to the platform, and the back axle weight noted at intervals. At each weighing a photograph was made (Fig. 4). The series of photographs provided a table from which at any time the right number of weights could be placed on the platform in a known position and so add a known ballast to the back axle.

Implement Working: Special Technique Photography is of inestimable help in research on the action of implements in the field, but a rather special technique is required. When one small part of an implement is being investigated at work, a photographic record should emphasize that small part, yet leaving enough of the machine indistinctly in the picture to show the relation of the part to the whole. This calls for limiting the depth of focus and for an accurate means of controlling the differential focusing. The definition has to be sharp, right up

to the boundaries of the selected part of the machine. Beyond that area there must be softness of outline to throw into relief the main subject of the picture.

Let us consider as an example the photographing of the action of a coulter on a plough. The camera must have a long-focus, large-aperture lens, and focusing on a ground-glass must be possible to show exactly the depth of field at various lens apertures. Since the plough is to be photographed moving across the field, a stand-camera with focusing screen is of no use. A reflex camera is necessary, but it must also have some kind of direct-vision view-finder for following the plough and keeping the distance between plough and camera constant.

The best thing is to convert the reflex camera to dual-control. An optical range-finder is fastened on to the body of the camera. The point of mounting this distance meter must be determined carefully so that for distances over a few feet (far enough for parallax to have no influence) the image seen in the range-finder is in the centre of the field seen on the focusing screen. Then, by experiment, the lensboard carrier rail can be calibrated to correspond with the calibration of the range-finder.

In the field the camera is used in the following way. First, using the focusing screen, the picture is composed and accurately focused and given the right depth of definition with the plough stationary. Then the reading of the distance scale on the lensboard rail is noted. Suppose it reads 15 feet. The range-finder is set at 15 feet and the order given for the machine to start moving. The photographer stalks the machine across the field, using the range-finder as a view-finder and keeps it trained on what he has decided to be the central point of the desired picture.

If he is following directly in the wake of the machine he varies his speed of walking to increase or decrease the distance between himself and the machine until the images in the range-finder merge. If he is taking a view from the side or from the front of the machine he stands still and watches the images in the range-finder being changed by the approach of the machine. As soon as they coincide he releases the shutter.

Photomicrographs Entomology and botany often call for photomicrographs. Low-power photomicrographs can be taken satisfactorily by combining a stand camera with an ordinary microscope. A wooden stand should be made, rather like the support of a vertical enlarger, and near the top of the stand a hole bored to take a tripod-screw to hold the camera. Below the camera there must be a shelf for the microscope.

The microscope is placed upon the shelf, and its condensing mirror is adjusted to the source of light. The object slide is then placed on the stage of the microscope, which is focused and the part of the slide to be photographed selected.

Next, the eye-piece of the microscope is removed and the camera, with no lens in it, is fixed on to the upright support. The tube of the microscope must be extended until it meets, or slides inside, the lens mount of the camera. The join between the camera and the microscope must be light-proof; a velvet sleeve with elastic at both ends may be needed to make this join. Now the image on the ground-glass screen of the camera is examined, and made sharp by turning the focusing adjustment of the microscope.

The only way to estimate the length of time for the exposure is to make a trial exposure in strips. The shutter slide of the plate-holder should be pulled out half an inch or so and left for, say, four seconds. Then the slide should be pulled out another half an inch and left for a further four seconds and so on, until the slide has been drawn right out. The strips will have been exposed for four, eight, twelve, and sixteen seconds, and when the plate is

developed the strip showing the best graduated image can be taken as the one correctly exposed. This method will not hold accurately for a subject whose density varies widely in the chosen field, because it may be that the photograph of a dense place is being compared with the photograph of a thin place. Nevertheless this method is usually a guide within the limits of exposure latitude of the sensitized plate.

Fine-grained sensitized material should be used, so that the image can be magnified from the negative.

X-ray Photographs X-ray pictures can help in agriculture. Radiography for physiology usually demands apparatus beyond the reach of the general agricultural experimenter, but in botany and some other subjects rays of low penetrating power will suffice. Indeed hard rays are unsuitable for such work as, for instance, differentiating between the delicate variations of density in seeds lying in a pod. In most agricultural subjects, too, there is no need for great haste in taking the photograph.

The soft rays required for this kind of work can be generated in a very simple apparatus. All that is needed is a small Röntgen tube and an induction coil capable of giving about a 4-inch spark. Such a coil needs a 12-volt battery big enough to sustain a current of 3 amperes; a motor-car starting battery will serve.

Any grade of photographic plate may be used for making the record, but if much work is to be done it is worth while to get special X-ray plates or flat films.

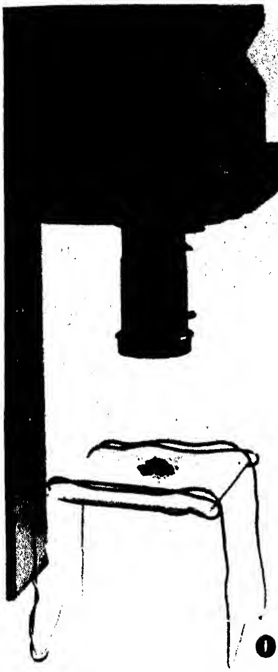
The plate or film is enclosed in a light-proof envelope. An ordinary plate-holder can be used for this, provided the shutter slide is fairly transparent to X-rays. Xylonite, celluloid and thin aluminium are transparent, but a shutter of iron sheet will offer some resistance to the passage of the rays.

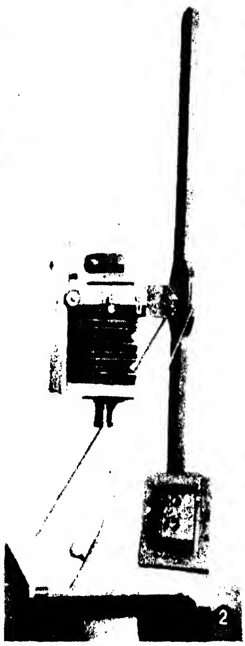
The holder is placed on the bench with the sensitized side of the plate face upwards. X-ray film material is coated on both sides, so that it does not matter which way round it is put into the holder. The object to be X-rayed is placed on the holder. Above them the Röntgen tube is fixed in a retort stand clip.

The rays emanate in all directions from a small area (almost a point) on the anticathode of the tube. Therefore, in order to get good perspective, the tube should be a fair distance away from the object and plate. But the intensity of X-rays, like the intensity of light rays, varies inversely with the square of the distance from the source; so with a low-powered apparatus the tube must not be too far from the plate, or the exposure required will be too long.

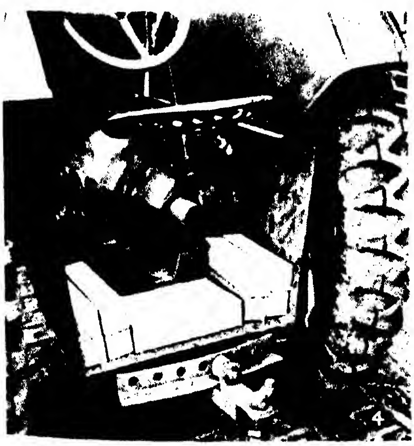
The plate must be placed perpendicular to a line from its centre to the anticathode, otherwise the image of the subject will be distorted. Also the subject must be as nearly as possible in contact with the plate, or else the image will be in wrong perspective and ill-defined.

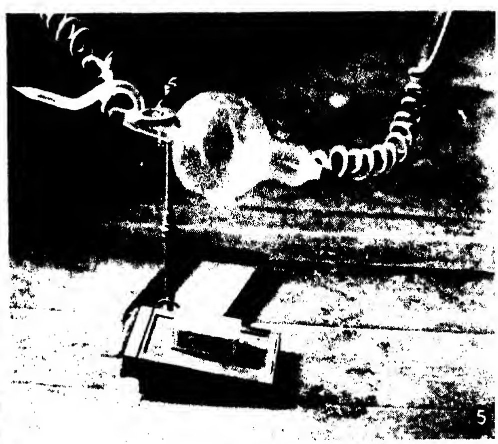
The length of exposure needed depends on (1) the quantity of current passing through the tube; (2) the opacity of the object being X-rayed; (3) the distance between the tube and the plate; and (4) the sensitivity of the plate to X-rays. As with photomicrography, a trial-and-error method must in most cases be used to find the length of exposure needed, but as many factors as possible should be kept constant. The opacity of the object and the distance between the tube and the plate are usually the only factors that need to be changed from exposure to exposure. The quantity of current passing through the tube should be kept constant by using a variable rheostat in the primary circuit of the induction coil, except when it is desired





1. Photographing from above small objects on improvised glass-topped table.
2. Camera converted to use miniature films, for photographing small objects.
3. Microscope and camera arranged for photomicrography.

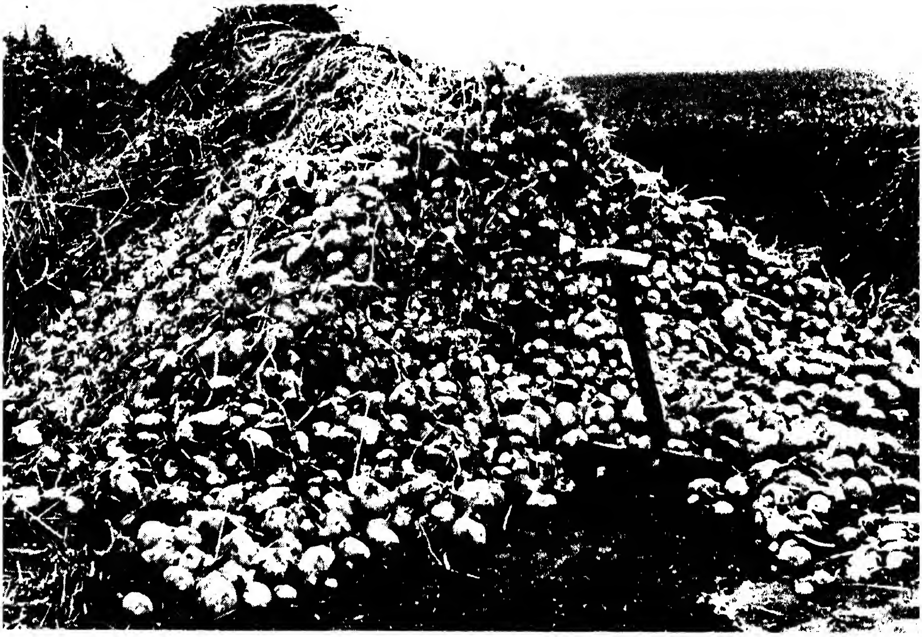




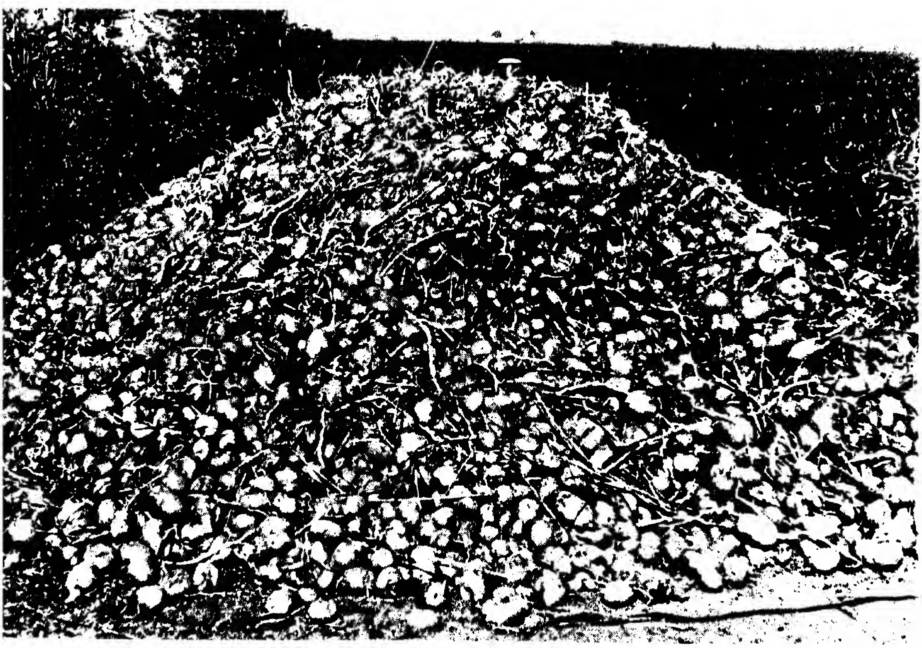
4. One of a series of photographs for use in a reference table.
5. Apparatus for taking X-ray photographs.

Photos: [illegible] J. Hine

PREVENTION OF EXCESSIVE SPROUTING IN LATE-STORED WARE POTATOES (See pp. 296-9)



Condition of potatoes in May in clamp treated with 5 lb. per ton 2 per cent Mana dust in previous October. Sprouts 0.9 per cent by weight of original tonnage clamped.



Condition of potatoes in May in untreated clamp. Sprouts 1.8 per cent by weight of original tonnage clamped.

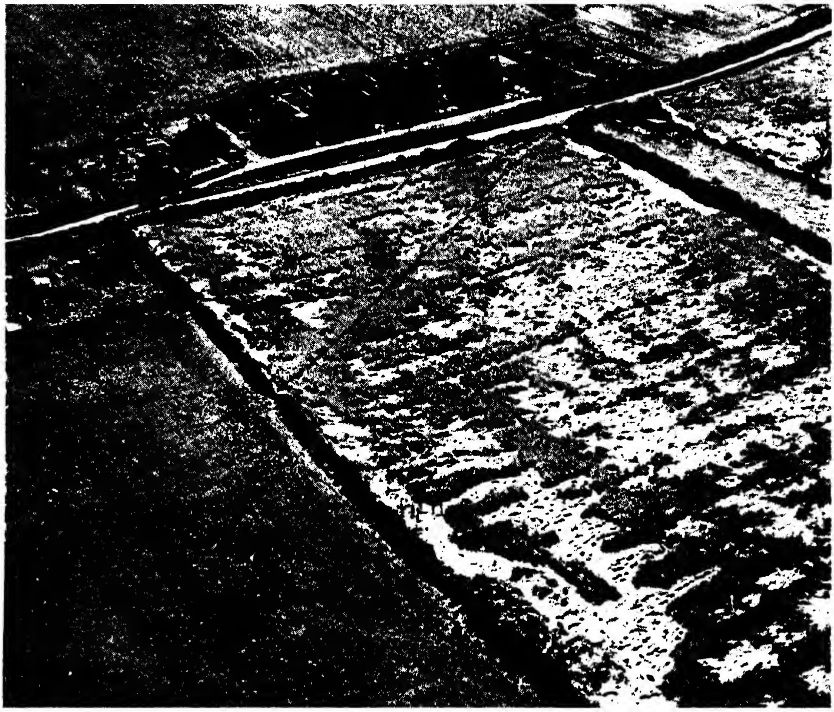
Photos: Agricultural Research Council

WINTER WORK IN THE FARM ORCHARD (See pp. 292-5)

Top-working fully developed apple trees

Preparations can soon be made for grafting over unprofitable varieties of apple and pear to those in market demand.

Photo: [illegible]



August has been a month of "trial and tribulation" for the farmer, and he and his staff have done a first-class job under very difficult conditions. Two laid fields of corn at Wotten-under-Edge, Glos.

Photos: *Aerofilms Ltd.*

to vary the penetrating quality of the rays to produce a harder or softer picture. When the quality of the rays is being changed for a series of pictures it is a good plan to have some constant object of which trial exposures can be made. A box full of matches serves well, because if the matches appear distinct and separate in the image, then the rays are not too strong and the length of exposure given in the trial must have been within the latitude of the emulsion of the plate.

Miniature Films Many agricultural research workers using photography prefer miniature films to plates and the larger sizes of films. Miniature photography has been made possible by new methods of sensitizing films. Fine grain films give a negative built up of grains so small that the image can be enlarged many times before the grain shows on the print. The size of picture which has become nearly standard for miniature photography is 24 × 36 mm., which is provided by two frames of 35 mm. cinematograph stock. The usual focal length of lens for this miniature picture is 50 mm. and a lens of this short length has great depth of focus.

In photographing plants out-of-doors, either singly or in mass, the great depth of focus is often useful All the planes of a plant can be brought into focus, and even when the lens is used at high aperture the exposure times can be short enough to nullify the effect of the swaying of the plant in the wind.

Changing to miniature photography for all operations often means discarding existing apparatus. It is possible, however, to make conversions, so that small roll films can be used in a plate apparatus with the existing lenses and shutters. Unless new objectives are bought, such a conversion will lack the advantage of the short focus of the lenses of miniature cameras, but there are some few occasions when the long focus lens will be better; for example, when slow perspective or differential focusing is required. Also, much laboratory work—for example, photomicrography—does not need the camera lens at all.

The best way to convert the apparatus is to fix a roll-film camera body on to one of the plate-holders of the old apparatus. A cheap and simple camera body can be used; the only important requirements are that it is light-proof and that the film is kept flat in the focal plane. Such a camera body is more likely to be available in a size that takes 8 or 16 exposures on a roll of vest pocket size of film, than in cinematograph film size. Sixteen exposures on vest pocket film give a picture size of 4 × 3 cm.

The plate camera used in the conversion illustrated on p. i of the art inset took quarter plates (4¼ inches × 3¼ inches) in double book-form dark slides. Two identical film camera bodies were available, so one was used to hold the film and the other to take a focusing screen. From each of the two plate-holders the dividing panel was removed. An opening was cut in one of the shutter slides in each plate-holder and the body of a film camera was fixed into this opening. Care was taken that the two camera bodies were in the same plane relative to the plate-holders. For focusing, an aperture of about 4 × 3 cm. was cut in the back of the camera body, and the second shutter-slide removed. A strip of tracing paper was cut to the same width as the film, and threaded on to the spool-holders in the camera. This translucent paper serves as a focusing screen; when it becomes dirty or yellow a new section of paper can be brought into position simply by turning the film transport key.

The second shutter-slide is retained in the film-holding camera and taken out only when the exposure is to be made. With the shutter replaced the holder can be removed to make room for the focusing camera body.

Fig. 2 shows this converted camera fixed to a vertical enlarger support, for photographing downwards. This camera can also be used as an enlarger, by replacing the film-holder slide with a lamp-house, condensing lens, and negative-holder, which have been fastened to another dummy slide.

If only one film camera body is available, a piece of ground-glass, built up into the right plane, can be fixed on to the second plate-holder as a focusing screen.

If it is desired to use 35-mm. film instead of the vest pocket size a further conversion can be made. Spools can be blanked off at the ends, by a filling of plastic wood, or by a strip of paper wound on to the spindle and secured by glue. A new backing paper to suit the width of the 35 mm. film can be cut, and appropriate spacing numbers can be written on the back of the paper. A mask must be fitted in to the picture frame aperture to bring it to 24 × 36 mm. The conversion to 35 mm. film makes available a far greater range of grades of sensitized material. This is important in the matter of sensitivity to colour.

Colour Work To be adequate and reliable as records, photographs of plants need either to be in colour or to give a faithful monochrome rendering in various shades of grey.

An ordinary photographic plate or film is sensitive only to rays having low wave lengths, and it records only ultra-violet rays, violet rays, indigo blue, and blue-green. Green, yellow, orange and red all register as black, and these are colours which in botany it is important to distinguish.

Orthochromatic films are sensitive to green. Panchromatic plates are sensitive to the whole visible range of light. Nevertheless, even a panchromatic film is not sensitive to the various colours in the same ratio as is the eye. Panchromatic films are relatively more sensitive to red than is the eye. Some blues appear to us quite dark, but they are registered strongly on even a panchromatic plate. Filters are necessary, therefore, to hold back some of the rays. A filter yellowish-green in colour holds back blue and violet and also slightly restrains the red. This, then, is the filter to be used with a panchromatic film.

Partial colour correction can, of course, be obtained by using suitable filters on an orthochromatic film, but the exposure time has to be increased considerably, because orange rays allowed to pass the filter act only slowly upon the orthochromatic emulsion. It follows from their nature that while ordinary films can be handled and developed safely in a green or yellow light, orthochromatic films need a red safe light, and panchromatic films complete darkness.

In close-up work it is well to have the filter in position on the lens when focusing. The cone of rays is lengthened by about one-third of the thickness of the filter. In addition, if the filter should not be flat and plane parallel then, of course, a quite different alteration in the path of the rays will be caused by refraction.

In photomicrography, however, the filter is better placed between the light-source and the subject, instead of between the subject and its image. Then the filter, even if its optical quality is poor, will not interfere with the rays passing from the subject to the eye-piece or sensitized plate. Most colour filters also eliminate ultra-violet rays.

Infra-red Photographs We have been considering the sensitivity of films and plates within the visual part of the spectrum. Plates and films are made which are sensitive also to infra-red rays. By using a filter which blocks out all the visible spectrum it is possible

to take a photograph by infra-red rays only. Such a photograph sometimes gives details which are invisible to the eye but are delineated by wave-length differences within the extra-visual part of the spectrum. For instance, if the chlorophyll or other constituents of leaf cells have been destroyed by parasites, or by drying or burning, the damaged areas show as dark patches on the print from an infra-red negative.

Infra-red photography can, for example, help in the study of potato virus disease. Again the necrotic areas in "streak" diseases are not defined well in ordinary photographs, but in an infra-red photograph they show clearly as black on a white background of the healthy part of the leaf.

In photomicrography an infra-red plate will sometimes record detail that would not be shown on ordinary or panchromatic plates. Cell walls and chloroplasts are more transparent to infra-red than to visible light. Bleaching of insect specimens is often made unnecessary by the use of infra-red plates in photomicrography.

A deep red, almost opaque, filter is used for infra-red photography. Special photographic lenses are made in which the visual focus and the infra-red focus coincide. In most ordinary lenses and microscope objectives and eye-pieces there is a considerable difference between the visual and the infra-red focus. This makes focusing difficult, for it is impossible to focus with the filter in position. The correction in focal length can be made only by trial and error. Focusing through a red filter will lessen the correction needed.

References

BAWDEN, F. C. "Infra-red Photography and Plant Virus Diseases", *Nature* (1933), **132**, 168.

CLARK, W. *Photography by Infra-red.* Chapman and Hall (1947).

HINE, H. J. "Photographing Agricultural Machinery". *British Journal of Photography* (1938), 451.

ZEISS, CARL and COMPANY. *Directions for Photographing Microscopic Objects.* (1938).

Sales of Milk off Farms—August, 1948

The Milk Marketing Board state that sales of milk off farms in England and Wales during August amounted to 111 million gallons. This is another record quantity, and is nearly 5 million gallons greater than the previous highest August figure.

CORN HARVEST, 1948: GLOUCESTER STORY

JOHN CLAPHAM, B.Sc., N.D.A., N.D.D.
County Agricultural Officer, Gloucestershire

BY the end of the August Bank Holiday week most of the hay had been gathered, and the county needed a good soaking, for the hot sun during the last fortnight in July had burnt things up. The trees were beginning to take on their autumn colours, and the elms, in particular, were starting to shed their leaves. The pastures were parched, and the majority of dairy farmers were praying for rain, even at the expense of some lodging in their corn crops.

The rain came; some areas receiving a deluge, and others practically none. By far the worst was a violent hailstorm in the Winchcombe district on August 3, when hailstones as big as walnuts came down with sufficient force to break windows. The intensity of rain varied from field to field, and continued to do so throughout the first three weeks in August. A combine harvester was seen working in one field, whilst in another field, a little more than 300 yards away, half-an-hour's heavy rain had brought operations to a standstill. One farmer listened to it raining for over two hours in the middle of the night, and the following morning instructed his men to go manure-hauling, only to find that his winter oats which he had been combining the previous day—approximately 200 yards from the farmhouse—were not even damp.

In some localities practically the whole of the corn was flattened; in others, all was standing. Taking the county throughout, winter oats and winter barley were hit the hardest; spring corn stood remarkably well.

Linseed is a new venture to the majority of Gloucestershire farmers, and they have been more concerned about the harvesting of this crop than the growing of it. Down went the linseed after every storm, but the following day most of it came up again. I asked one farmer how his linseed was standing. the strain. He told me that it had been down seven times already, but it was "a beautiful standing crop that morning".

Our farmers have been surprised at the amount of publicity given them in the press during this month of trouble. There is no doubt at all that each laid crop, and every additional shower, added to their expense and worry, but there was no suggestion that the national larder was being jeopardized to any appreciable extent. We have known less moisture, followed by warm, still conditions, do a tremendous amount of damage. This year we were fortunate in that the rain was nearly always followed by fairly high winds; but it was very tantalizing to the farmer when, just as the field was fit to cut or carry, the rain came down again. Nevertheless, there was little or no "growing out"— such as there was occurred mainly in badly laid fields of winter corn.

It is estimated that our losses are somewhere in the region of 5 to 8 per cent, and these for the most part were due to the corn crops getting too ripe and shedding.

This season has certainly brought home the value of combine harvesters, which are being employed in increasing numbers in Gloucestershire. It was amazing to see the way they tackled some of the laid crops, and there is no doubt that the combine is the tool for the job. By its use good yields have been salvaged and there has been practically no loss.

More pick-up balers have also been used this season, and although the straw is, in most cases, of poorer quality than usual, it is at least being saved instead of burnt.

As regards wheat, the county has suffered badly from Take-all and Eyespot. Many farmers saw their fields turn black overnight as a result of Black Mould, presumably due to the weather. Heads affected by Take-all were found to contain only a few shrivelled grains, or none at all. Some farmers in our less fertile areas have termed the disease " Took-all " ! It has been estimated that approximately 30 per cent of our wheat crops have, to some degree or other, been attacked this season. We have, nevertheless, seen harvested some magnificent crops of Jubilegem and Bersée, and several fields are yielding up to 20 sacks per acre. Barley, dredge corn and oats will even now yield slightly above the average, although several fields of oats were severely attacked by frit fly.

The land is now (end of August) moist enough to start autumn ploughing immediately, and the grassland is a beautiful spring green. The cattle and sheep look exceptionally well, the milk yields have been more than maintained, and the prospects for winter keep are good.

August has been a month of " trial and tribulation " for the farmer, and he and his staff have done a first-class job under very difficult conditions.

The cost of harvesting in some instances has exceeded the value of the grain obtained, and it has been amazing to see how the farmer has "stolen" the crops during the fine spells. The food supply, as far as Gloucestershire is concerned, has not been appreciably reduced.

INTERNATIONAL SCHEME FOR THE CONTROL OF COLORADO BEETLE

V. E. WILKINS, PH.D., O.B.E.
(President of the International Committee)
Ministry of Agriculture and Fisheries

DURING the past twenty-five years the Colorado beetle has been spreading steadily from France northwards and eastwards until now it occurs over practically the whole of the western part of the European continent. War conditions have assisted in this spread because of the necessary interference with such measures of control as governments of European countries have sought to impose. Since the cessation of hostilities and with the re-opening of traffic between this country and the Continent, the beetle has again made sporadic appearances in Great Britain and has given this country a direct interest in the measures which are being taken by individual governments on the Continent to deal with this pest.

The purpose of the present article is to explain what the International Control Scheme is designed to achieve, and to give a brief indication of the progress made in the first year of its operation.

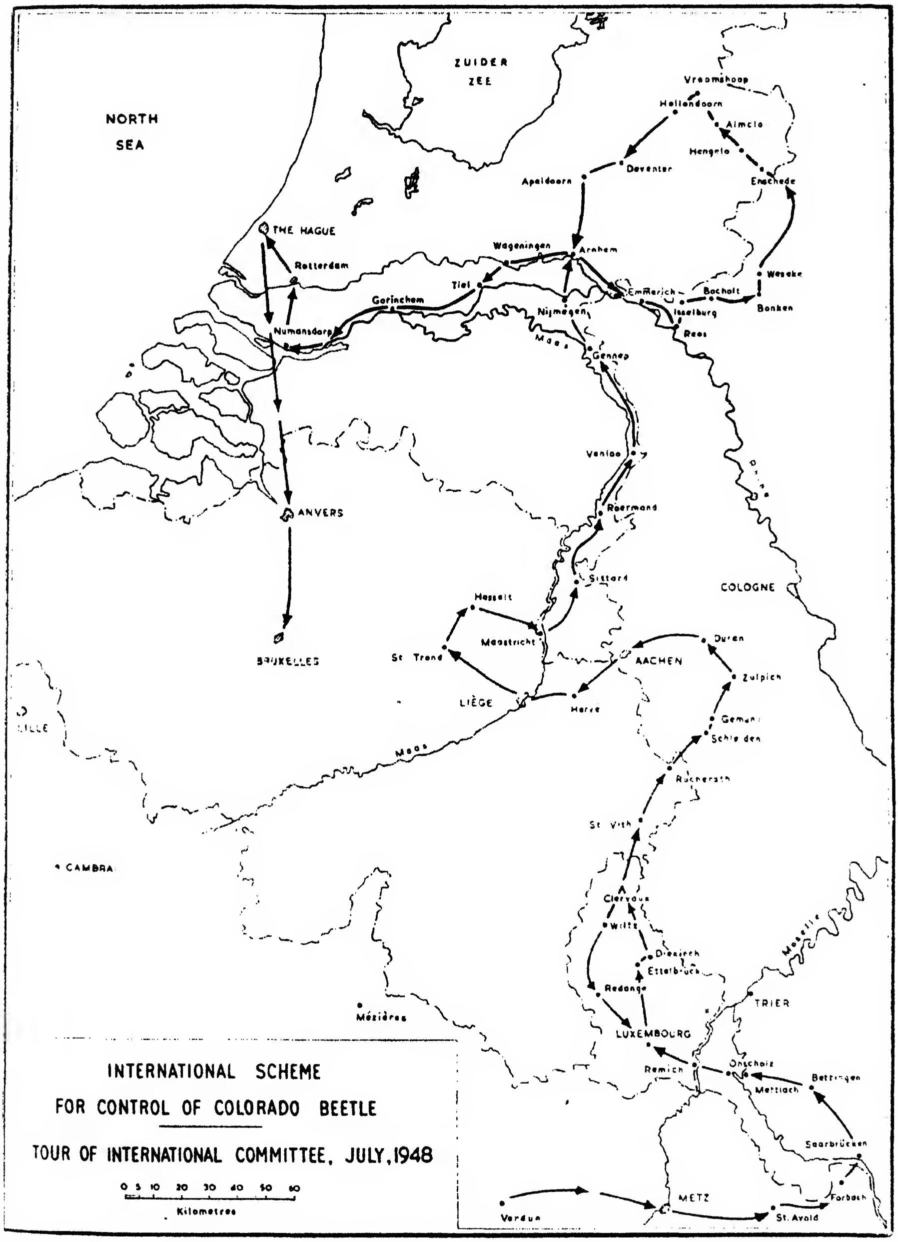
A Suggestion bears Fruit The suggestion for coördinated action was first put forward in the summer of last year. It met with general approval in the limited circle of Government officials with whom it was discussed. An International Conference was then convened in Brussels in October, 1947, and was attended by representatives of several of the Western European Governments, of the United Kingdom, Eire, and the Jersey States. The Allied Control Commission for Germany, sent an observer to the Conference. Both before and since that meeting at which unanimous recommendations in favour of proceeding with a scheme

were agreed, a great deal of spadework had to be done, and done quickly, in order to get things moving in time to make a start in 1948. In the result, an International Committee was established, consisting of administrative and technical representatives of the countries cooperating in the initial scheme, namely, Holland, Belgium, Luxemburg, France, Eire, Jersey, and the United Kingdom, with the Control Commission again associated through an observer. An Executive and Finance Committee of four persons was appointed to deal with matters arising between meetings of the main Committee. Money was voted by several of the associated Governments for extra work in their countries against Colorado beetle, and some of this extra money went into a Central Fund for the financing of projects arising from work of a coordinating and supervisory nature in connection with the scheme. By arrangement with Plant Protection Ltd., Mr. R. C. Stotter was appointed as advisory coordinator, with headquarters at Brussels, to act as a general focusing point for operations affecting the International Scheme as a whole.

There is no doubt that this season witnessed a very great extension of anti-Colorado beetle activities on the Continent, and this can definitely be attributed to the introduction of the scheme. It is too early to speak of "results"; in fact, in dealing with a pest such as this, the incidence of which is necessarily so closely related to the vagaries of the weather, it may well be unsafe ever to attempt to draw conclusions as to the effect of coordinated action. It may suffice to state that both in Belgium and northern France, where in many areas the beetle had got almost completely out of hand, vigorous and sustained progaganda campaigns have led to a thorough rousing of public interest in its control, and in Holland the excellent work already carried out by the Phytopathological Service of the Dutch Government has been still further augmented. In Germany the scheme has embraced the two or three-times spraying of potato crops in a 20 Km. zone down the whole length of the frontier from the Dutch coast to south of Luxemburg.

The Central Fund has proved of the utmost value. It has financed the greater part of the intensive Belgian propaganda campaign; between 15 and 20 qualified technicians have been specially appointed to supervise this campaign, and have received preliminary courses of training at Gembloux in Belgium, Wageningen in Holland, and Fernhurst in England. Motor-cars have been acquired for the use of the expanded inspectorial services. Insecticides have been purchased for the spraying of the protective zone along the German frontier. An international propaganda film is in process of being made. A secretariat, modest enough but adequate for the immediate purpose, has been maintained. Finally—a small item but a most important one—the expenses of Government representatives travelling outside their own countries on behalf of the International Committee have been defrayed from the Central Fund.

Close Collaboration Although assessment of *technical* results may be unwise or even impossible, there is one aspect of the scheme on which a definite appraisement is certainly justified. From the outset, the relations between the various Government representatives on the Committee have been harmonious and happy. In this lies the best augury for success in the future. Moreover, it is worth emphasizing that these representatives include both senior administrative officers and technical officials. The Colorado beetle has succeeded in bringing together a happy combination of the men who carry responsibility for decisions to act and the experts who have real knowledge of the problems to be faced and solved.



So at least it may be claimed that a good start has been made on the road to international collaboration, administrative and technical, based on a genuine need to deal with a common problem, and involving financial contributions to a common fund.

An idea of the territory covered by the 1948 scheme can be gained from the map reproduced here, which shows the course of a tour of some of the protective zones made by the International Committee last July. Starting from Paris on July 17, the Committee travelled nearly two thousand miles in nine days and did a great deal of inspection. From this tour, and from

reports already received on the work done under the scheme, the Committee was well satisfied that sufficient progress had been made to justify an invitation to other countries to join. With the ready approval of the Swiss Government, the United Kingdom Government has accordingly, at the Committee's request, invited all European Governments to send representatives to another International Conference to consider the desirability of extending the scheme next year. This Conference will take place in Berne from October 13 to 16, 1948.

Commonsense Approach In conclusion, it is desirable to mention one aspect of this scheme to which countries with an export trade in fruit and vegetables naturally attach considerable importance. Great Britain and Ireland are among the countries of Europe in which the beetle army has not yet secured a "bridgehead." Although isolated beetles can be, and are, brought into those countries on ordinary merchandise and through the normal passenger traffic, there is little doubt that there is greater risk of introducing beetles through the importation of vegetables and other plants. If the pest succeeded in establishing itself among our potato crops, the consequence would be serious not only by reason of loss in yield of crop, but also because of the heavy cost in labour, machinery and materials needed to keep the beetle under control. Severe restrictions are therefore imposed on imports of vegetables and plants during the season when beetles are active, and this involves serious loss of trade to the countries concerned. As progress is made under the international scheme and there is clear evidence of effective control of the beetle being established in areas from which vegetables and plants are exported to Great Britain, these restrictions will be reviewed and such modifications made as would be compatible with the safeguarding of our crops from risk of infestation.

In short, the international scheme has the added merit of approaching in a sensible way the problem of a pest which threatens production in all countries alike. Merely to limit the importation of vegetables that may carry the pest is neither progressive nor statesmanlike: it leads to constant irritation and occasional charges of unreasonableness, and while costly in administration is uncertain in its results. It is much wiser to get together, work on a common and coordinated plan, and endeavour to eliminate this pest, so that production and trade may proceed with the minimum of restrictions.

Tom Newman Memorial Medal

Poultry Association of Great Britain has decided to institute a permanent memorial to be linked with the name of the late Mr. Tom Newman who did so much for poultry husbandry. Because of his world-wide reputation the Association feels that the memorial should be of an international kind, taking the form of a medal awarded annually for the most outstanding contribution in poultry research. The medal will be known as "The Tom Newman Memorial Medal for Poultry Research" awarded by Poultry Association of Great Britain. Details in connection with the award have, however, still to be worked out.

TWO BLADES OF GRASS

AGRICULTURAL research in the United States is predominantly a government function and is spread over a vast federal-state network which consists of the Department of Agriculture, with its associated Agricultural Research Centre and Plant Industry Station (both at Beltsville, Maryland), the State agricultural experimental stations and land-grant colleges, the Department's four huge regional research laboratories, and the nine Bankhead-Jones laboratories. In addition, the Department and the states have a number of widely scattered sub-stations and experimental farms.

The major research agencies in the Department of Agriculture are the Forest Service, the Soil Conservation Service, the Agricultural Research Administration and, in the field of social services, the Bureau of Agricultural Economics. The agencies comprising the Agricultural Research Administration are the bureaux of Agricultural and Industrial Chemistry, Animal Industry, Dairy Industry, Entomology and Plant Quarantine, Human Nutrition and Home Economics, Plant Industry, Soils and Agricultural Engineering, and the Office of Experiment Stations.

In his recent book, *Two Blades of Grass*,* Mr. T. Swann Harding, who joined the Chemistry Division of the U.S. Department of Agriculture over thirty years ago, surveys the development of research of his Department since its inception in 1862. His account, clearly written for the non-technical reader, makes most interesting reading.

Chemistry He recalls the early research work of men like Dr. Harvey A. Wiley—chemist, publicist, and statesman—whose study of sugar beet demonstrated the commercial possibilities of the crop for America. He studied the effects of latitude, altitude, sunshine, rainfall and other environmental factors on the growth and sugar content of the beets. Before his work efforts to grow sugar beet in America had been sporadic and ill-planned.

The same man is remembered, too, for his classic investigation into food adulteration. In the latter part of the nineteenth century "cottonseed oil was a common adulterant of butter and lard; coconut shells, olive seed, rice bran, sawdust, and other foreign substances were used to adulterate spices; candies abounded in poisonous colouring matter and added metallic substances; honey was adulterated with glucose or cane syrup; chicory was a common adulterant of coffee, and brick dust, sand, copper and gypsum, appeared in tea. Poisonous preservatives were used freely in meat and other products".

A group of employees in Dr. Wiley's Chemistry Division, who came to be known as the "Poison Squad," had perforce to adopt an empirical approach to the problem, eating at their place of business for many months to discover whether food preservatives commonly being used in food processing were inimical to health. The slogan of the squad was aptly: "Only the brave can eat the fare"! The result of these researches had their sequel when later the first Food and Drugs Act was passed by Congress.

Insect Pest Control Referring to the work of the Division of Entomology, Mr. Harding recalls that in 1886 Fluted Scale was introduced from Australia into the citrus-fruit orchards of California, where it spread rapidly and so weakening orchards that many had to be destroyed. The dense, fluted, cottony mass secreted by the female made the eggs practically impervious to the insecticides available at that time. "In 1886 Charles V. Riley decided that an organism so obnoxious

* University of Oklahoma Press. $3.50.

must have enemies somewhere, and he determined to find them. As Australia was believed to be the home of the pest, he sent Albert Koebele there to investigate. Later Koebele brought back thousands of living parasitic enemies of the scale, among them ***Vedalia* (*Novius*) *cardinalis*.** The Vedalia beetle propagated and spread with amazing rapidity, stripping the scale from the trees. It saved the citrus-fruit industry of California and has, for the past fifty years, kept the scale well under control."

Similarly the citrus black fly was fought in Cuba by importing a predator which kept it under control and prevented it from entering Florida to attack the citrus crop there.

From the earliest days of cotton production the bollworm and the cotton-leaf worm have been responsible for a great deal of damage. Control of these insects was among the first important problems to engage the attention of U.S. Department entomologists. The spread of the boll weevil from Mexico to Texas in 1892 and its establishment in that state during the next decade was directly responsible for the great expansion of the Department's entomological research. Indirectly it also enlarged the U.S. Department's activities; for instance, the far-flung Extension Service grew out of Farm Demonstration work begun by the Department in its campaign against the boll weevil. No insect has caused such widespread devastation and economic depression in the United States as the boll weevil after it really got a hold. From the first cultural practices used to combat this pest in 1895, investigation was both extensive and unremitting. During the 1914-18 war calcium arsenate was developed as an insecticide for boll weevil control, and its subsequent use was expanded so greatly that in 1941–42 some 70 million lb. of it were used for the control of cotton pests in the U.S.A.

Plant Breeding Another U.S. Department of Agriculture scientist, C. V. Piper, was instrumental, in 1909, in introducing into America the emergency ley and pasture plant to which so many British farmers visiting America during and since the war have referred—Sudan grass. From a single 8-oz. packet of seed the use of the grass has spread to practically every state. In 1941, says Mr. Harding, nearly 93 million lb. of seed were produced in the United States.

Crested wheat grass, a long-lived, cold- and drought-resistant bunch grass native to the cold, dry regions of Russia and Siberia, was introduced in 1898. By 1920, under the aegis of the state experimental station it was being produced commercially in Montana, and is now invaluable to many northern plains stockmen.

George Washington, addressing Congress on December 7, 1796, said:

> It will not be doubted that with reference either to individual or national welfare, agriculture is of primary importance. In proportion as nations advance in population and other circumstances of maturity, this truth becomes more apparent and renders the cultivation of the soil more and more an object of public patronage. Institutions for promoting it grow up, supported by the public purse; and to what object can it be dedicated with greater propriety?

That the public duty laid upon American agricultural scientists has been zealously discharged is abundantly clear from Mr. Harding's excellent history.

S.R.O'H.

WINTER RATIONS FOR LIVESTOCK

RATIONS during the coming winter will, in general, be on the same scale as during the months October, 1947 to April, 1948. In the case of milk production rations, however, it has been found necessary to widen the ratio of protein to cereals owing to the shortage, both present and prospective, of supplies of protein feedingstuffs. The ration will be 1 cwt. protein and 3½ cwt. cereals for each 118 gallons of milk in excess of 15 gallons per cow per month, subject to a reduction of 60 lb. of cereal per cow per month. This alteration in the ratio is unavoidable, but if the supply position of proteins improves, the previous ratio of 1 to 3 will be restored during the course of the winter period. The revised ratio applies also to milch goats.

Brief particulars of the rationing arrangements for the principal classes of stock are given below.

DAIRY HERDS

Milk Production Rations Rations during the winter months will again be based on sales of milk two months previously. The monthly allowance will be as described above and dairy farmers will be expected to provide maintenance for their cows, together with protein for the first half gallon and cereals for the first 1⅛ gallons of milk per cow per day.

Supplementary Dairy Rations Supplementary allowances for dairy cows will be available only to the very limited extent permitted by the quantities available from the Agricultural Executive Committee's discretionary reserves. It may not be possible to meet the farmer's needs in full and, in general, assistance will have to be confined to the waiving in whole or in part of the monthly cereal deduction of 60 lb. per cow in cases where farmers have grown essential crops.

Other Provisions There will be provisions similar to those in operation last winter whereby (a) rations for winter milk producers may be allowed on estimated sales for any two consecutive months from October to February, if rations based on actual sales two months previously will be inadequate because of the large number of cows calving in the meantime; and (b) the cereal deduction or part thereof may be postponed if a farmer is temporarily unable to thresh his oats or dredge corn and has no other fodder crops to take their place.

It is still not possible to re-introduce the arrangements under which milk producers could, by selling a quantity of oats equal to the cereal deduction, obtain equivalent cereal coupons to enable them to use all their coupons for the purchase of compounds. Farmers who wish to use compounds in their milk production rations must be content to take them only to the extent that they can provide coupons in the correct proportions and to buy "straight" feedingstuffs with the remaining odd coupons.

Calves under Six Months For each calf up to the age of six months being reared for milk or beef production the allowance will be ½ cwt. of calf food per month. This allowance will not normally be made where the owner is not selling milk.

WORKING HORSES

Rations on the same scale as in previous winters will be allowed only where insufficient home-grown oats are available. The allowances vary according to the type of horse and the nature of its work.

WINTER RATIONS FOR LIVESTOCK

COMMERCIAL PIGS AND POULTRY

Basic Rations For the months September, 1948, to April, 1949, inclusive, basic rations at the rate of 1 cwt. per pig and 1 cwt. per 20 poultry will be allowed for up to one-fifth of the registered numbers of pigs and poultry kept on the holding in June, 1939, or December, 1940, subject to a deduction of 1 pig for each 64 acres and 3 birds for each 16 acres of the holding.

Farrowing Sows The allowance made on application in respect of each sow or gilt about to farrow will continue at the current rate of 8 cwt. per sow. This allowance is normally available only for pigs kept on a holding eligible for basic pig rations. It is not available to domestic pig-keepers.

Hatcheries Hatcheries rationed on the basis of their purchases of feedingstuffs in 1939 will receive monthly rations from September 1, limited to one-quarter of the purchases in the corresponding months of 1939.

Chick-rearing Rations for Replacement Purposes Chick-food coupons will be available during January to April, 1949, at the rate of 1 cwt. for each 40 birds shown in the Agricultural Return at June 4, 1948, where at least 26 birds of all ages were so returned. These rations are not available to domestic poultry keepers who do not make Agricultural Returns or to poultry keepers holding a Small Poultry Keeper's ration card or to hatcheries rationed on the basis of their pre-war purchases.

Coupons available for the period September to December, 1948, may be obtained if application is made before the end of October for autumn coupons in lieu of spring coupons by any poultry keeper eligible for an issue who desires to rear chicks before the end of the year. In this event the coupons for the January to April period will be correspondingly reduced.

Other Pig and Poultry Rations Rations for pedigree pigs, premium boars and poultry breeding stock will remain at the rates in operation during this summer. Rations for accredited poultry breeding stock will be based for September and October, 1948, on the number of adult birds at the time of the autumn, 1947, inspections, and for November, 1948, to April, 1949, on the numbers ascertained at the autumn, 1948 inspections.

Extended Scheme for Pig and Poultry Rations As announced by the Minister of Agriculture and Fisheries on July 20, the extended rationing scheme for pigs and poultry kept on holdings of over 1 acre will come into operation on October 1, 1948. Under this scheme rations will be allowed, to those who applied by August 21, for not more than a specified number of pigs or poultry according to the acreage of the holding, and will represent up to about one-half of what is needed to maintain the stock. New applications under this scheme cannot be accepted until further notice.

Stockowners who have elected to enter the extended scheme will not be eligible to receive any basic rations under the existing scheme, nor to receive the pedigree pig allowance or the ration for accredited poultry breeding stock. Custodians of premium boars, however, who elect to be rationed under the new scheme are not thereby precluded from receiving their supplementary ration for a premium boar. The allowance for farrowing sows under the new scheme will be 6 cwt. for not more than a specified number of sows.

Coupon Ratio Coupons for pigs and poultry will again be issued in the proportion of 1 protein to 9 cereal.

DOMESTIC POULTRY AND PIGS, AND PIG CLUBS

There will be no change in these rations, which will continue at current rates.

MOUNTAIN EWES

A farmer who qualifies for the Hill Sheep subsidy may be allowed coupons for up to 1 cwt. per 20 mountain ewes, if he is unable to provide the extra feeding which, on account of bad weather, may be required at lambing time. This allowance may, on application, be issued in advance to farmers whose farms are likely to be isolated in severe weather, in order that they may purchase the feedingstuffs for holding in reserve.

OTHER CLASSES OF STOCK

Rations for other classes of stock for which specified ration scales were in operation last winter, e.g., bull calves in officially milk-recorded or pedigree dairy herds, premium bulls being used for service, goats, pedigree ram lambs, etc., will be on the same scale as last winter, except that where applicable the ratio of 1 protein to 3½ cereals will operate. In the case of milch goats the monthly ration allowed will be 4½ cwt. for each 118 gallons of milk instead of 4 cwt. for each 105 gallons as during last winter, subject to a deduction of up to ¼ cwt. cereal per goat where the Agricultural Executive Committee is satisfied that the owner can provide a similar quantity of equivalent feeding-stuffs.

DISCRETIONARY RESERVES

Issues may be made at the discretion of Agricultural Executive Committees, from such reserves of protein and cereal as it is found possible to place at their disposal, to certain classes of stock in case of need. A large proportion of these limited reserves will, as indicated above, be required for making supplementary allowances in respect of dairy herds. This applies especially to certain areas where there is special difficulty in attaining the standard of self-sufficiency required under the rationing scheme. Only small issues limited to cases of acute need will be possible in respect of other classes of stock.

Separate announcements will be made by the Department of Agriculture for Scotland and the Ministry of Agriculture for Northern Ireland.

FARMING AFFAIRS

Science and its Application In his inaugural address as president of the British Association, Sir Henry Tizard looked back sixty years and compared the material state of the country then with what it is now. We are no longer the greatest manufacturing nation in the world. In the inter-war period there had been a great increase of research by industry and by Government, and a surge of discovery which put Great Britain in the van of progress in nearly all branches of science. But leadership in scientific and industrial research, allied to experience in commerce and manufacture, and to skill in craftsmanship, had not enabled our country

to maintain its position among the nations of the world. Was the main cause of our relative decline that research was on too small a scale, or should we seek for other reasons ?

The primary object of industrial research was severely practical. And it had, or should have, the special object of reducing the labour required to supply the material needs and wants of men. All social progress such as spread of education, promotion of health, opportunities for leisure and healthy recreation must depend on the power of science and technology to increase the productivity of industry.

He believed that it was not the general expansion of research that was of first importance for the restoration of the country's industrial health, and certainly not the expansion of Government research remote from the everyday problems of industry. It was far more important to apply what was already known. No new discovery in any field was likely to have so quick and beneficial an effect as the application of what was already known. Pure invention still had its place ; but unless we could raise our standard of technology, unless there were many more men in executive positions in industry whose practical experience had been preceded by a scientific education, we should inevitably fail to keep our place among the great manufacturing nations.

Turning to another branch of applied science—the prevention and cure of disease—the President mentioned the immense improvement in general health. All over the world endemic diseases are being fought with success. The world population is rising rapidly, and with it the call for food. The fight against human disease must be reinforced by corresponding measures against disease among plants and domestic animals, and improved methods of cultivation must be vigorously pursued. So far as this country is concerned we must plan our economy on the assumption that food would be scarce and dear for many years to come. There was, he said, a consensus of expert opinion that the production of food in the United Kingdom could be raised by 20 per cent within five years by a combination of measures, such as the improvement of grasslands, the conservation of grass for winter feeding, the control of pests and weeds, the extended use of fertilizers, and the development of large tracts of marginal land. But even so it would still be our bounden duty, and the only certain way of safeguarding our future so long as we remained a large food-importing country, to develop our colonial territories, particularly the under-populated African colonies, where the increase in population that would follow the control of disease and the increase of food supply would open fresh markets for international trade.

Times were difficult, he said in conclusion, but " difficulties are bracing to a nation which has not lost the resilience of youth". What was chiefly needed was to find the right way to combine originality in science with enterprise and speed in its application.

Long Ashton Annual Report, 1947 Another year's progress in horticultural research is recorded in the 240-page Annual Report for 1947 from the Agricultural and Horticultural Research Station, Long Ashton, Bristol.* A summary of its contents is given below.

A group of papers on Black Currants includes an account of the new varieties bred by Mr. Spinks, and a survey by Mr. Hobbis of the relations between variety, planting distance and cropping. Dr. Bould emphasizes the high nitrogen requirement of black currants, especially Mendip Cross, and

*Obtainable from the Station, price 10s.

proves that composts and stable manure are not adequate sources of nitrogen for this crop. It is shown by Dr. Pollard and Miss Bryan that although increase in the nitrogen uptake of the bush lowers the vitamin C and sugar content of the fruit, yet the overriding effect of nitrogen in improving yield ensures the highest production of vitamin C per acre from the bushes receiving adequate nitrogen. Control of black currant leaf spot and the effect of spray residues on the canned fruit is dealt with in a joint paper by Mr. Marsh and members of the Campden staff.

The attention being paid to the technical problems in the cider industry is reflected in the number of papers on CIDER FRUIT production and on problems of cider-making. Professor Barker lists the cider varieties approved for post-war planting and, with Mr. Hobbis and Dr. Kearns, discusses the prospects of cider fruit production on bush trees. Records of yields from this system of planting are supplied by Mr. Stanton, who, with Mr. Burroughs deals with the effect of cover crop and rootstock on the composition of the juices made from the apples on the bush plots. The first of a series of studies on the chemistry of cider, dealing comprehensively with the bittersweet ciders from the varieties Yarlington Mill and Medaille d'Or, is presented by Dr. Challinor and Mr. Burroughs. Data on the vitamin content of ciders are supplied by Mrs. James. Drs. Challinor and Pollard with Miss Kieser describe the promising results obtained in stabilizing juices by passing them through ion exchange absorbents. Progress in domestic apple juice production is reported by Miss Crang, Mrs. James and Miss Sturdy. The same authors give the results of a series of tests on the times and temperatures necessary for efficient bottling of fruit, using the oven heating process. In another paper they report on the preserving qualities of eight varieties of rhubarb.

INSECTICIDES are dealt with by Mr. Bennett and Dr. Martin, who record tests with hexaethyl tetraphosphate (HETP) from three sources: no differences between the samples appeared. A chlorinated dicyclopentadiene (Chlordane) and a chlorinated camphene (Toxaphene) were both effective stomach poisons to larvae of *Mamestre brassicae*: para-nitrophenyl diethyl thiophosphate (E 605) proved extremely toxic to these larvae. The compound bis (betafluoroethoxymethane) was found to have the remarkable power of conferring insecticidal properties on beans, cauliflowers, etc., when watered in dilute solution on to the soil in which these plants were growing. Warning is given of the potential danger of this fluorine compound to human beings and stock.

In the work on PLANT NUTRITION, Professor Wallace sums up ten years' experiments on magnesium deficiency of apple, and shows that the best control is obtained by foliage spraying. Dr. Hewitt, Mr. Jones and Dr. Nicholas detail the methods used for studying molybdenum deficiency in sand culture, and list the visual symptoms of this disorder in tomato and brassica crops. The relation of molybdenum deficiency to "whiptail" of cauliflowers is discussed. Dr. Nicholas and Mr. Fielding describe the use of cultures of the fungus *Aspergillus niger* in assaying magnesium, copper, zinc and molybdenum in soils. Dr. Hewitt continues his study of soil acidity and distinguishes the specific effects on crop plants of aluminium toxicity, manganese toxicity and calcium deficiency. The same author, with Drs. Plant and Nicholas, gives further results of the application of lime and fertilizers to potatoes in a strongly acid soil.

Three papers by Dr. Nicholas and Mr. Catlow on manurial experiments on potato and cauliflower show that nitrogen deficiency was the most serious factor in reducing yield and that this deficiency occurred when bulky organic manures such as farmyard manure or straw/sewage sludge were used without the addition of a nitrogenous fertilizer. In discussing another series

of manurial trials on these crops, Dr. Bould and Mr. Catlow point out that as the potassium/magnesium ratio in the soil rises, the absorption of magnesium by the plant falls, but if the exchangeable soil potassium remains reasonably constant, then the uptake of magnesium by the plants rises with increased exchangeable magnesium. Leaf spraying of magnesium-deficient potatoes with 2 per cent Kieserite significantly increased the yield. Dr. Pollard, Miss Kieser and Miss Crang confirm earlier findings on potato quality by showing that liability to blacken on cooking is affected by site, variety, and nutritional status of the plant. On the better sites correction of deficiencies greatly improved quality.

Dr. Luckwill's studies on the use of GROWTH-REGULATING SUBSTANCES show that methyl alpha-naphthyl methyl ether, which is cheaper than methyl alpha-naphthalene acetic acid, is a promising substitute for the latter in the suppression of sprouting of stored potatoes. Apples treated after picking with growth-regulating substances showed no increase in storage life, and wrapping the apples in paper impregnated with the methyl ester of 1-naphthyl acetic acid had most deleterious effects on the fruit. Mr. Crowdy gives a preliminary report on the use of growth-regulating substances in the treatment of apple branch infections with canker (*Nectria galligena*). The same author, with Mr. Forshaw, describes and figures a new bark disease of apple that has lately appeared in Somerset.

Devon Lace It is to the Flemish and Huguenot refugees who sought asylum in this country in the seventeenth century that we owe, among other industries, the introduction of lace-making. Some of them, says Mr. Norman Wymer in his new book, *A Breath of England,** landed at Beer in S. Devon and " lost no time in setting up their industry and in teaching the art to the villagers. In course of time the craft spread throughout the county, with Honiton assuming the position of lace-maker's " capital " by virtue of its convenient position as a collecting and distributing centre at a time when transport was all but non-existent.

" Lace-schools were soon set up throughout the length and breadth of Devon, and these formed the main system of education for many generations. Nobody seems to have minded greatly whether a girl could read or spell, or whether, in fact, she could even write her own name, so long as she could make lace ; and this she would learn to do as soon as she was five.

" It was at Beer that the lace was made for Queen Victoria's wedding dress, and the villagers still talk with pride of how Jane Bidney mustered together a hundred of the best craftswomen from all over the county, and executed the work at a cost of something like £1,000. So pleased with the result was the young queen that she at once sent word for the lacemaker to come to London to see her. But, alas, the ordeal proved too much for poor Jane, who was not used to such things ; the story goes that she swooned while awaiting the audience.

" Beer's link with royalty has not yet been wholly severed. A descendant of Jane Bidney still keeps the village lace-shop, and it is to her that Queen Mary sends her precious collection for periodic re-conditioning."

" The young girls of today prefer to visit the cinema rather than sit before their " pillows," but the Devon County Council are trying to bring about a revival in the re-establishment of the old-time lace-classes. A county organizer now travels from place to place superintending these classes, while many villages boast a salaried instructor whose duty it is to teach the art to children and adults alike."

*Lutterworth Press. 15s.

FARMING AFFAIRS

In the prosaic progress of everyday life there is a danger of overlooking our wealth of tradition, custom, legend, and folklore. In the first book of a new series, Mr. Wymer recalls those still to be found in southern England. He brings them out, one after another, like age-encrusted bottles of wine, mellow and rich, and holds them up to the light for our delectation.

Standardized Farm and Horticultural Buildings A committee has recently been formed by the British Standards Institution under the Chairmanship of Mr. P. J. Moss to consider the application of standardization to farm and horticultural buildings for materials, components and equipment. The formation of this committee is the development of the work of the Ministry of Agriculture of the standardization of components for farm buildings.

The Ministry of Agriculture and Fisheries, the Departments of Agriculture for Scotland and Northern Ireland, the National Farmers' Union, National Farmers' Union of Scotland, the Land Agents' Society, the National Union of Agricultural Workers, the Agricultural Section of the Transport and General Workers' Union, and a large number of professional institutions and manufacturing organizations are cooperating with the British Standards Institution in the work of the committee.

The committee has already begun the preparation of British Standards for structural components for general farm buildings following the lines of the Ministry of Agriculture standard components for farm buildings. British Standards are also to be prepared for Dutch lights, together with the associated supports and fastenings, and for farm gates.

This new committee is additional to the two committees which the British Standards Institution has already working on agricultural problems ; these committees are the Agricultural Implements and Machinery Committee and the Dairying Committee.

It is intended to extend the preparation of British Standards to cover various components, materials and equipment applicable to farming and horticulture, and the committees will be pleased to consider any suggestions for standardization that will contribute to increased efficiency and production.

Selenium for Pest Control—A Warning Investigations have shown that certain substances applied to the soil can be taken up by plants and will make the plants so treated poisonous to certain pests that attack them. Among the substances that show this striking property are compounds of selenium such as sodium selenate, and these materials have lately been tried by a few growers for the control of chrysanthemum eelworm and some other pests of flower crops. This is dangerous, because selenium compounds are insidious poisons to man. Moreover, they may persist for long periods in the soil, and if food crops are grown later in treated soil the plants may take up the poison in sufficient quantity to make them injurious to health if eaten.

It may be that further research work will show ways in which insecticides acting through the plant can be employed safely, but at present neither sodium selenate nor any seleniun compound should in any circumstances be used for pest control purposes. The Ministry understands that no proprietary insecticide containing selenium is manufactured in this country.

BOOK REVIEWS

The Land of Britain: Its Use and Misuse. L. DUDLEY STAMP. Longmans' Green. 42s.

The toal area of land in England, Scotland and Wales is 56 million acres—about 1¼ acres for every head of the population. Of this area, nearly one-third is mountain and moorland, and only some 2¼ million acres land of really first-class agricultural quality.

One does not need statistics to be aware of the drawings which industry, housing, transport and military training have made and are making on this pool at the expense of agriculture; and some of those drawings must continue in the future.

Dr. Stamp, who is Chief Adviser on Rural Land Use to the Ministry of Agriculture, and was responsible for organizing the Land Utilization Survey, which was a field-to-field survey of land use in England, Wales and Scotland, undertaken chiefly in the years 1931-34, is in a unique position to discuss a problem to which he has devoted so much time, energy, and thought.

This book describes the organization of the survey, but, while discussing the material obtained, it is not a mere summary of the survey, but a most in'eresting discussion of the various factors which have determined the intricate pattern of the countryside. The book describes the development of British rural life and farming and the influence upon them of history, climate, and land structure. From this sound basis it proceeds to discuss the needs and methods of future planning.

The story is a fascinating one which should give both urban and agricultural readers a new understanding of British agriculture. Regarded simply as an agricultural textbook, the chapters on farming are to be recommended. But of course Dr. Stamp is able to do more than write about British agriculture and the factors which have influenced its evolution. He is able to point the road ahead and to tell us something about the lines on which we must make our inadequate acres serve multiple needs.

The publication of this book so close to the passing of the Town and Country Planning Act, 1947, is most opportune, and quite apart from its larger public it will be of especial value to planning officers in town and country.

R.R.W.

The Land and Wildlife. EDWARD H. GRAHAM. Oxford University Press. 16s.

This book is written by the Chief of the Biology Division of the U.S. Soil Erosion Service, and is concerned with the restoration of wild life on deteriorated lands and its conservation on farm lands generally. In particular, he discusses the ways in which ponds, marshes, ditches, hedges, croplands and woodlots can be managed so as to combine good and profitable land use with the encouragement of wild life.

" Wildlife " in America usually means birds and mammals, and chiefly those species that are of interest to the sportsman, who pays the bill (or sees politically that it is paid) for an enormous amount of research and management of game that is carried out by government agencies. The author is well qualified to handle the subject (his earlier book *Natural Principles of Land Use* gives a first-rate introduction to ecological ideas). American experience in managing wild life habitats on a large scale should be valuable to us, and especially to the new Biological Service in Britain when it gets going, even though many of the situations are different. Thus, where the Americans worry over the grazing of woodlots by cattle, we have to contend with the rabbit and with the effects of block-planting of even-aged pure stands of trees; where they are just planting hedges on a larger scale, some farmers are (probably unwisely) beginning to grub theirs up; and they still have a mammal fauna that makes ours look silly, partly, of course, through having immense wilderness forests and national parks as reserves for wild life.

The author has a tendency to talk about wild life as if it were a single category of stuff that you consume like "meat" or put back like "grass"; whereas one is dealing with hundreds of separate species, each with its special niche, attraction, and suitability. But the book, with its excellent history of American conservation, its survey of the different habitats left for animals in a cultivated landscape, its determination to show that rich animal life is not inconsistent with sensible land use, and its fine photographs (many of them on the " before " and " after " principle), will help anyone to think out his own ways of building up the wild life populations he wants, especially by the manipulation of marginal habitats.

C.E.

BOOK REVIEWS

Tall Corn. E. M. Barraud. Chapman and Hall. 10s. 6d.

The title of Miss Barraud's latest book may suggest some kind of literary residue, threshed out of earlier writing. Nothing could be farther from the truth ; it is corn of the first quality.

Country-born, but town-bred, Miss Barraud came back to the land with the W.L.A. in 1939. She came, she saw, and was conquered ; and in this book, looking out at the life of the countryside, as it were, from the window of her Cambridgeshire cottage, she reminisces with interest, observes with accuracy, and comments with understanding.

For all the machinery we have brought into the field, we are still glad to fall back sometimes on the older methods and simpler tools. Tom was of the old school, and to watch him opening up a field of corn with his scythe was a privilege. It was he who taught Miss Barraud the knack of it :

> " The old man turned to me, holding out his scythe. ' You 'ave a go, mate,' he said. I was torn by two terrors, terror of the long, thin, snake-like hungry steel in my untutored hands, terror of his hurt if I declined so high an honour. I held out my hands and he clasped them round the nibs, standing beside me, kicking my feet into the right position, pushing my shoulder forward."

Later Miss Barraud recalls that four old men were called in to deal with a laid crop.

> " Each man had a scythe in his hands and as I stopped to look they drew the whetstones from the leather strips at their belts and began to sharpen the scythes. As the stones whistled back and forth along the lean blades the men talked quietly. ' That ain't so bad along the edge,' said one of the men. ' It's out in the middle we'll happen on trouble.' ' Are you going to mow the whole field ? ' I asked. ' Yes, mate. The binder'd never tackle the most of it, and tain't worth bringing it in for the little part what does stand.' He laughed a little and there was pride in his laugh. ' They can't get on without us yet, seemingly—not when anything goes wrong ! "

This year's harvest has testified to that.

Miss Barraud speaks of the village shops, still " vital focal points in village life," although their shelves, once so richly stocked with an assortment of foodstuffs, clothing, haberdashery and hardware, are now denuded by scarcity.

> " Shopping in a village shop is a social activity at least as much as a business affair. There is always someone in there, and it is always someone you have not seen for ages. Even if it happens to be someone you do not know, they will be talking about someone you *do* know, or something of interest. The shop is a great mart for news as well as goods. Go in for a penny stamp, and you come out with the village in microcosm."

The author's own cottage was once a village shop from whose joists and struts used to hang the heterogeneous collection of pots, pans, brushes and brooms—and home-cured hams. The kindliness of the old lady who kept the shop is still remembered.

> " ' Ah,' says the old 'un, ' now she were a proper sort. She niver kep' ' er thumb in the scale time she weighed you an ounce of baccy.' "

Maybe the old lay's mantle has fallen upon Miss Barraud, for it is the same human touch that she brings to her writing.

S.R.O'H.

Modern Poultry Husbandry. Leonard Robinson. Crosby Lockwood. 21s.

Most books dealing with poultry husbandry concern themselves with a very specialized branch, and all too often for this reason are of little value to the practising poultry-keeper, who rarely has the scientific equipment to assimilate and make use of the information so presented. Also many of the general books on poultry husbandry, written by well-meaning practical men, fail because their authors are ignorant of the underlying scientific principles of their craft.

It is therefore refreshing to find in Mr. Robinson's book that the basic scientific principles of the science of poultry husbandry are set out in a readable manner and the methods whereby the poultry-keeper can make use of this information given in a clear and lucid fashion. It has a very commonsense approach, and although perhaps the more specialised sections, such as disease, will not be of great interest to the specialist in that subject, the book will give to the practising poultry-keeper a good insight into the science and practice of his craft.

R.C.

BOOK REVIEWS

A Description of the Recommended Varieties of Wheat and Barley. F. EARNSHAW. National Institute of Agricultural Botany. 10s.

Amongst its other activities the National Institute of Agricultural Botany is concerned with the field inspection of cereal crops intended for seed, and has been training inspectors in the identification of cereal varieties. The training is based on varietal characters as set out in this bulletin, the publication of which is intended to make the distinguishing characters more widely known. The varieties described are those included in the "Recommended List" issued by the N.I.A.B. and the material now presented in attractive and readable form is likely to be studied with interest by teachers, students and farmers alike.

J.G.S.

The Fruit and the Soil. Collected Edition of the John Innes Leaflets. Oliver and Boyd. 3s. 6d.

The special value of the leaflets issued by the John Innes Horticultural Institution lies in the fact that they give the latest results of research. One leaflet particularly, *The Fertility Rules in Fruit Planting*, has long been the standard authority on an important aspect of fruit culture. The publication of a single, reasonably-priced volume containing six of the leaflets, revised and brought up to date, is very welcome. Perhaps the most useful leaflet in the volume is No. 3, which gives working details of the construction of the John Innes Soil Steriliser at a cost, for materials, of below £40. This little book is one which few horticulturists can afford not to have in their possession.

A.H.H.

Agricultural Engineering Record, Autumn, 1948. NATIONAL INSTITUTE OF AGRICULTURAL ENGINEERING. H. M. Stationery Office. 1s. (1s. 1d. by post.)

In the previous issue of *Agricultural Engineering Record*, the N.I.A.E. announced that a new horticultural section had been formed, although it might be some time before any worthwhile results of work could be published. It is therefore encouraging to find two articles in the Autumn, 1948, issue of *The Record* contributed by members of the horticultural staff. One concerns experiments carried out to improve the insulation of greenhouses by the use of aluminium foil placed close to the glass; the other gives the N.I.A.E. views on the design of a tractor that would be most suitable for the horticulturist. Some of the suggestions are novel, but it is interesting to note that one of them—the mounting of the engine behind the driver—has been adopted in at least one tractor in production.

One day, seed breeders will, no doubt, produce a strain of sugar-beet seed that will obviate the disadvantages of natural seed at hoeing time. A study in this issue of precision drilling of sugar-beet seed in America describes the methods tried in that country to reduce the labour demand of gapping and singling; the problem has been approached simultaneously along several different lines, and the study includes not only the latest developments in seed breeding and processing but also describes and illustrates some types of single-seeder drill mechanisms in use, as well as touching on mechanical thinning.

Also in this issue are an account of a pea-harvesting survey, a description of German machines for cleaning and shredding sugar-beet tops before they are ensiled or dried, instructions on how to make a bean drill for mounting to the toolbar of a Fergusson tractor, and a description of ways by which the power requirement of forage-harvesters can be reduced.

Summaries of reports on machines recently tested by the N.I.A.E. include the Robot direct-attached potato planter, Stahmer-Markham fertilizer and lime distributor, Fairmile cutter-blower, Hart F.Y.M. spreader, Forward potato web links, Nife and Oldham tractor batteries, and the loosemore land leveller.

 4045 Wt. 15 CN&Co 10/48 466

There's more than stock food in a BIBBY bag . . .

. . . there's everything that contributes to high quality and good value . . . extensive research both in our laboratories, and on our Experimental Farms . . . fresh raw materials straight from our own seed crushing mills . . . an extensive and well designed plant ensuring accuracy and economy in manufacture and a nation-wide and efficient distributio.. system direct from "mill to farm."

A part of the Silo Mixing Plant, Poultry Food Department.

BIBBY

BIBBY & SONS LTD. LIVERPOOL 3

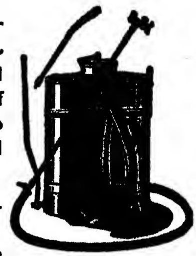
1190A

"MYSTO"

KNAPSACK SPRAYERS

. . . *save TIME & LABOUR*

. . Specially made for spraying Fruit Trees, Vines, Hops, Potatoes, etc., and for the destruction of Charlock—comfortable to wear, easy to operate and particularly efficient.



No. 1 model is for use with non-corrosive liquids.

No. 3 model for Corrosive Mixtures.

FROM YOUR LOCAL DEALER

★ We also make a complete range of **LIMEWASHING and SPRAYING MACHINES.**

W. T. FRENCH & SON LTD.

'MYSTO' WORKS - BIRMINGHAM, 16

STENT GRAIN STORAGE BINS

After this years weather every Farmer knows the importance of adequate Grain Storage. Heavily increased demands have proved the value of STENT GRAIN STORAGE BINS.

TO AVOID DISAPPOINTMENT PLACE YOUR ORDER NOW FOR 1949 HARVEST.

The Stent Bin is also suitable for Green Silage.

Our bins are suitable for installation in existing buildings; or we can supply Buildings and Bins complete. Send for prices and particulars **NOW.**

STENT *PRECAST CONCRETE LTD*

1 · VICTORIA STREET · WESTMINSTER S·W·1

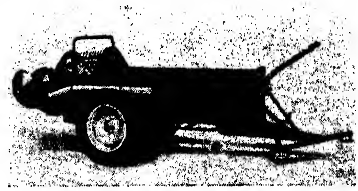
Telephone: Whitehall 2573

L2548

WINNING NEW CONFIDENCE

in British-built Farm Machinery

All the world over, leading farmers have a strong preference for MASSEY-HARRIS farming equipment, for there is over a century of experience behind every machine produced. At the Manchester plant of MASSEY-HARRIS LIMITED, modern farm machinery is being built which is the equal of any produced anywhere in the world. The No. 711 Tractor Spreader is specially designed and sturdily built for speedy tractor operation. Roller bearing equipped, the No. 711 is smooth working and light in draught.



No. 711 TRACTOR SPREADER

Latest type two wheel Spreader, specially designed for tractor spreading. Low body facilitates fast and easy loading. Five speed adjustments. Built-in screw jack enables quick adjustment to meet draw-bar of any tractor.

MASSEY-HARRIS

LIMITED

MODERN FARM MACHINERY

BARTON DOCK ROAD . STRETFORD

MANCHESTER

By Appointment to H.M. King George VI

Please mention the JOURNAL *when corresponding with Advertisers*

Agriculture

PUBLISHED 6d MONTHLY

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

Editorial Offices: St. Andrew's Place, Regent's Park, N.W.1 (*Phone: WELbeck* 7711)

VOL. LV | No. 9 | DECEMBER 1948

Contents

Cover Photograph

At the end of a hard day on a North Wales hill farm .. .. *Crown Copyright*

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LV No. 9 DECEMBER 1948

WINTER GRAZING FOR DAIRY COWS

GLOUCESTERSHIRE INVESTIGATION

J. R. STUBBS, N.D.A.
National Agricultural Advisory Service, Gloucester

SHORTAGE of labour and good quality food during the winter are two major problems of the dairy farmer. Is it possible to reduce the labour connected with, say, kale growing? Over the past four winters an attempt has been made in Gloucestershire to explore the possibilities of grazing special crops. From data so far obtained it is gradually becoming possible to evolve rotations which may provide grazing all the year round. This objective has already been attained on one farm, and will probably be achieved this year on several others.

That grass as grazed is the cheapest possible summer food was illustrated on the Ministry's Stand at the Royal Show, 1947. Evidence from 73 farms showed that grass supplied no less than half the total food nutrients of the dairy cow per year at only one-quarter of the total food cost. The evidence collected from farms in Gloucestershire indicates, likewise, that the winter grazing crop is the cheapest food in winter and at the same time carries milk-stimulating properties, although not so marked as that obtained from spring grass. It is produced at a very low cost and with very little effort. It provides fresh food in the dead months of the year. It is often produced on land which would otherwise be fallow. Moreover, it is available when milk prices are at their highest level.

History Before 1944, all observation was directed towards the value of Italian ryegrass and trefoil sown in cereal crops to give extra autumn and early spring grazing. The mixture generally used was 10–15 lb. Italian ryegrass and 2–4 lb. trefoil per acre. Very valuable grazing was obtained, but several troubles arose:

(1) Italian ryegrass, if sown too early, grew up in the corn and caused trouble at harvest time.
(2) The catch crop interfered with stubble cleaning, particularly on the Cotswolds.
(3) In the spring the Italian ryegrass mixtures were so early and so valuable that it was with considerable reluctance that they were re-ploughed for corn crops!

The possibility of specially grown kale, rape and cereals for winter grazing was receiving attention at this time, and in the autumn of 1944 two separate experiences had a profound effect on the subsequent course of development. One was on the farm of J. S. Eley at North Nibley, and the other on the farm of Mr. J. H. Wilcox at Stonehouse. Mr. Eley sowed what was known as "Eley's mad mixture" on a 5-acre field after early potatoes. The mixture was of a "hit-or-miss" nature, consisting of rape,

Italian ryegrass, crimson clover, turnips and oats. From those 5 acres over £100 worth of milk was sold at a total cost of only £7 2s. 6d. for seed, and this n mid-winter from a field which would normally have been idle. The experience encouraged us to lay down several trial plots in the following year on Mr. Eley's farm, and from these plots almost the whole of our current practice has emerged. These and subsequent trials indicate that simple, pure crops are on the whole better than any "complex" mixture.

On the second farm Mr. Wilcox had a crop of oats undersown to a one-year clover ley. The oats shed badly at harvest time, and by November there was a mass of "britted" oats and clover all growing together. Dairy cows were used to graze off the crop. The field is sited alongside a hard road and on a good-textured soil with a gravel subsoil, and is therefore particularly well suited to winter grazing. There was a marked rise in the milk yield which was held during the whole of the grazing period. Feeding the crop needed no more trouble than opening the gate and letting the herd in and out.

In July, 1945, a crop of clover hay was taken. It was re-ploughed in late July, and 8 acres sown during the first week of August with a mixture of 10 lb. thousandhead kale and 15 lb. Italian ryegrass per acre: the ryegrass was completely smothered out by the kale. The crop provided grazing for 40 cows (non-pedigree Shorthorns) from January 4, 1946, to March 7, 1946; an average of 34 of these were in milk, and the average yield during the period was 85 gallons daily. Thus the 8 acres provided 310 cow-grazing days per acre. The milk yield averaged 2½ gallons per cow in milk over the whole period, and the hay ration was cut by more than half. The history from this stage has been as follows:

March 11, 1946	Re-ploughed.
March 18, 1946	Planted to barley, which yielded 14 sacks per acre.
September, 1946	Planted to a mixture of 3 bushels oats, ½ bushel vetches, and 10 lb. Italian ryegrass.
April, 1947	Grazed.
June, 1947	Hay.
July, 1947	Grazed.
September, 1947	The Italian ryegrass was in seed head, so it was pitchpoled twice over, thus obtaining a free seeding of pure Italian ryegrass.

In March, 1948, there was a dense mass of Italian ryegrass, but since there was sufficient kale and cereal grazing at this time, it was not grazed until April. The field was ploughed and sown to thousandhead kale in May of this year.

There has been no attempt to standardize the method of growing or feeding these winter grazing crops. To do so would only hamper progress. Therefore, after having considered the evidence presented at various demonstrations and discussions, each farmer has adopted the method best suited to his own conditions; thus some crops are broadcast and some are drilled, some are folded off by the use of an electric fence, while others are ranched. Sowing dates have varied from May to August and grazing from one hour a day to day and night grazing. The amount of hay fed daily has varied from nil to *ad lib.* feeding, and various methods of rationing concentrates have been adopted. By recording these various methods and analysing final results, it is possible to lay plans for future work.

Recommended Practice By and large, the most successful species for winter grazing have been thousandhead kale and rape, and the simplest practice is to sow rape for feeding before Christmas and thousandhead kale for feeding after Christmas. The important point regarding rape is its extreme susceptibility to mildew, and where sown too early, i.e., before the middle of July, a September attack of mildew may well reduce its yield by half. Bearing this in mind, it is preferable to sow the thousandhead kale first, if a very heavy crop is required, and delay sowing the rape until later, which, nevertheless, will be grazed off from October onwards. The seeding rate in either case should be from 6 to 10 lb. per acre—either broadcast or drilled, according to conditions at the time of sowing ; drilling is preferable when the seedbed is dry.

After a clover ley or on fertile land, good results can be obtained from late sowing, i.e., up to the first week in August. The great advantage arising from this late sowing is that there is no trouble whatsoever from weeds such as fat hen and red lash. Furthermore the quality of the crop at the time of consumption is very high and no trouble is experienced from mildew on rape.

Late sowings are not recommended unless the fertility of the land is very high, and the best date appears to be around the first fortnight in July for rape and as early as May for thousandhead kale. Where the land is foul with such weeds as fat hen, charlock and red lash, the final harrowings should be with a chain-link harrow and not a spike harrow of any kind, which is most likely to activate another crop of weeds.

As regards manuring, the best results have been obtained from 3 cwt. of potato fertilizer at the time of sowing, and 2 cwt. of a nitrogenous fertilizer when the plants are growing vigorously. Recorded evidence on two fields has shown an increase of 9 tons per acre of rape for the addition of 2 cwt. of a nitrogenous fertilizer. It is also observed that where the crop is heavy, there is practically a 100 per cent smother of annual weeds.

Amount of Food Produced and Cost The average yield of rape and thousandhead kale from the June–July sowing lies between 12 and 15 tons per acre. On the whole, early sowing has given the heaviest crop, except where late sowing has followed a "nitrogen accumulator" such as a clover ley or a half-fallow. In the latter case both yield and quality have always been extremely high, and weeds almost completely absent. It is possible that the legume "nitrogen factory" is the ideal preparation for a brassica winter grazing crop, both on the score of economy and quality of produce. This possibility must be studied carefully in any long-term winter grazing programme.

Two hundred to three hundred meals, each of 1 cwt. of rape or kale, during the winter is about average, and the usual costs of the production of a winter grazing crop are as follows:

	With farm equipment		Man-hours	All contract job
	s.	*d.*		*s.*
Cultivations (including sowing)	37	6	6.5	93
Fertilizers	48		—	48
Seed	20		—	20
Rent	20		—	20
	125	6	6.5	181

Kale Grown and Carted compared with Kale Grazed An interesting comparison between traditional kale growing and grazing kale is as follows:

(This is a recorded comparison on one farm where the two methods were running side by side.)

	Kale Carted	Kale Grazed
Cost, including feeding	£23 14s. 6d.	£6 1s. 0d.
Yield (estimated)	30 tons per acre	19 tons per acre (check weighted)
Man-hours per acre	84.7	9
Cost per ton	15s. 10d.	6s. 4½d.

In this particular comparison the traditional kale was following turf. There was no weed trouble and very few cultivations were necessary. The crop yield was exceptionally heavy, and the winter grazing crop above the average.

Dr. Dawe of the Department of Economics, Bristol University, recently stated that the average man-hour requirement for an acre of kale is 134: this is twelve times greater than the average winter grazing crop.

The winter of 1946–47 was very wet and perhaps a particularly bad one for kale carting. Time Studies on a few crops reveal the enormous amount of man-time taken up day by day on this task. The time necessary to cart and feed an acre of kale varied from 30 to 100 man-hours per acre, with an average figure of about 50. More than half of this time was taken up by daily repetition work, i.e., collecting equipment, travelling to and from the field, and negotiating the same muddy gateways, while little more than 30 per cent was accounted for by actual cutting, loading and feeding the kale. This analysis draws attention in a most striking way to the considerable amount of time used on this task where kale is grown and fed in the traditional manner.

Winter Grazing and High-yielding Herds Recorded data indicate quite clearly that high yields can be maintained on a winter grazing system. The story of one such herd concerns 18 acres of poor grass which was broken up and sown on August 1 with rape broadcast at 6 lb. per acre, 3 cwt. of potato fertilizer having been applied to the seedbed. Grazing began on October 16 and ended for the dairy herd on December 30 (there was a further month's keep for scavenger cattle).

Thus the 18 acres afforded 75 days grazing for a total of 51 pedigree Ayrshire cows, 37 of which were in milk. The average production during this period was 105 gallons, or 2.85 gallons per cow per day, and by December 30 the average production per cow in milk was 3.6 gallons per day. Four cows were giving 6 gallons, and one cow 7 gallons. No concentrates were fed for the first gallon of milk produced, and only 3 lb. was used for each gallon over the first.

Troubles The list of troubles include all those which have been met with at one time or another, together with others anticipated but not experienced. A note or two on our experiences during the past four years may be of value.

(1) Blowing. While this was very serious two years ago when grazing rape in July, there has been no trouble whatsoever in the winter period.
(2) Scour. Only on one occasion was scour reported. It occurred in an Ayrshire herd when the animals were changed from rape to thousandhead kale at Christmas time. Thousandhead kale is much more palatable than rape, and it appears that the trouble was brought about by the cattle

gorging themselves on it. The milk yield dropped by 5 or 6 gallons daily, but was back again to normal within a week. No trouble has been experienced from grazing either frozen or frosted kale, but in 1942 cases were reported of severe scour in store bullocks which were not receiving dry food.

(3) MILK TAINT occurred last year on one farm where the cattle were on the crop all day. No trouble has otherwise been reported or detected.

(4) POISONING. This item has been included because of an experience during the hot, dry summer of 1947, when three beef store cattle went blind on a rape pasture. Apparently this trouble is experienced in Canada and is reported to be due to the toxicity developed in hot, dry weather, similar to that which we experienced in 1947. Two of the three cattle recovered; the third remained permanently blind. No rape poisoning has occurred during the winter or with dairy cows. It is a trouble of exceptional circumstances. To avoid this, never turn cows on to rape when it is blue in colour due to hot dry weather.

(5) RED WATER is another obscure trouble which has occurred only once during our experience. This trouble has no connection whatever with tickborne red water. In the case we encountered a rest of four days from kale grazing was sufficient for recovery, and there was no recurrence of the trouble.

(6) WEEDS. To date, there has been very little trouble with weeds, but there are a few outstanding exceptions and, as the practice extends, more weed problems are being encountered. The story of one field is worth recording. Until sowing on June 30, successive crops of weeds were harrowed out and the rape and kale were sown under ideal conditions. The plant in early July was most promising, but to our surprise another crop of weeds germinated. On September 3 the crop was completely obscured by a solid smother of red lash, fat hen and charlock. At this stage there were three courses open to us:

(a) Ensile the lot;
(b) Feed off the crop immediately and re-plough;
(c) Leave it for winter grazing.

For the sake of future guidance and to learn more about the problem, the farmer very kindly agreed to (c), although to do this seemed ridiculous at the time. On October 2 the various weeds had shed their seeds and the kale and rape went ahead to a very heavy crop—384 cow-grazing days per acre. This year (1948) the whole field (six acres, four of which were winter grazing crops and two were mangolds) was sown to mixed corn (beans, peas, oats and barley). On April 24 a weed and crop count was taken over the whole field. The population of the crop was similar on both the winter grazing and the mangold portion, and written at 100. On the mangold portion the weed population was 3: on the winter grazing portion, the weed population was 880!

Arrangements were immediately made to spray the crop with sulphuric acid, and this was carried out on May 1, using 14 per cent strength. Spraying was completed by noon, and there was a heavy thunderstorm at three. Examination on May 3 revealed practically 100 per cent kill of weeds. The crop has now been harvested and threshed and yielded 21 cwt. of mixed corn per acre.

Sulphuric Acid to Control Weeds in Kale. At the time of spraying the mixed corn, a chance observation occurred which may be of great value to kale growing generally. A certain amount of kale and rape which had grown here and there in the mixed corn crop had been entirely unaffected by this strong sulphuric acid spray. The chance to make a further test with acid presented itself when the original field selected for winter grazing

on the farm of Mr. J. H. Wilcox was re-ploughed from Italian ryegrass this spring. It was sown to thousandhead kale in May, when a great number of weeds, including charlock, chickweed, fat hen, poppies, white campion, and a certain number of docks, grew up with the crop.

When the plants were about 6 inches high it was decided to test the effect of a sulphuric acid spray. A trial strip was sprayed on July 15 with 12 per cent acid. The weather was fairly hot, and the effect on the weeds was severe, but the kale was practically unaffected. On July 16 a second strip was sprayed with the inclusion of a "wetter". On July 20 the rest of the crop was sprayed, with the exception of one strip which has been left for comparative recording purposes.

At the present time, November 8, conditions are as follows:

(1) *Acid and Wetter Plot.* On the whole the kale plants appear to be stunted as if from nitrogen starvation. On the headlands, however, where more acid fell but where the soil is more fertile, the kale is 33 inches high and the density is 100 per cent. Poppies and campion were unaffected by the acid spray, and enough fat hen survived to give quite a fair scattering of weed seeds.

(2) *Acid Only Plot.* The best crop of kale is on this plot. Where poultry fold units were used last year, the kale is well over 20 tons per acre and is free from weeds.

(3) *No Treatment Plot.* Weed infestation is very bad indeed, but the kale has now taken charge and is estimated to be 75 per cent of the weight of the sprayed crop.

Three other crops have been sprayed with marked success, charlock in all cases being entirely killed and no harm whatsoever has been sustained by either the kale or rape.

The use of sulphuric acid for weed control in kale undoubtedly opens up many fascinating possibilities for both traditional and non-traditional methods of kale growing. Naturally, much more work is necessary.

General Considerations Every farmer must decide for himself if his soil conditions are suitable for winter grazing. The development in Gloucestershire, although mainly in the vale district, is on land capable of exploitation in this way, although up to the present we have every reason to be encouraged by the experiences we have had on some of the wet, heavy land. Many thousands of acres are lying fallow during the winter, a good deal of which could probably be used to produce winter grazing crops. Much of the Cotswolds is suitable, particularly where the surface soil is other than clay. It is intended that a good deal of information shall be collected from this area during the coming winter.

By means of rape and kale "pastures," food for young stock can be provided on the outlying fields of the farm during the winter in the normal course of a reseeding and grassland improvement programme, the sequence being as follows:

Plough from grass in May or June.
Fertilize well and broadcast rape or kale in July at 10 lb. per acre.
Graze during the winter.
Disc and reseed direct to grass in the following spring.

Poor fields treated in this way have yielded 20 tons of rape or kale per acre, have been reseeded, and carried stock on the new grass the following May.

Present and Future Work This year, experiments have been started on undersowing cereals with rape and kale. One of special interest is a spring-sown oat-and-vetch mixture ensiled in June and undersown with rape. The rape made very good growth after the removal of the silage crop, but has been attacked badly by mildew.

It is our intention this winter to find out how far concentrates can be reduced while the cattle are grazing.

Various methods are being used to combat annual weeds by:

(i) Heavy seed rates (10 lb. per acre kale or rape).
(ii) Use of sulphuric acid.
(iii) Late sowing after a clover ley.

Weed control is linked with the rotation followed. These are gradually being worked out for various circumstances from evidence now accumulating. One simple and profitable rotation is to alternate winter grazing crops with early potatoes, probably twice or thrice repeated, followed by a short or long ley. This year we have had several examples of early potato yields of 7 tons per acre and the same land is now carrying winter grazing crops of over 15 tons per acre. Furthermore, these potatoes are free from Blight and were harvested in July, a time when our dairy farmers, who had broken the haymaking peak by silage-making, had time to spare. Allied to the new process whereby early potatoes can be treated for utilization in late spring, this general policy should be quite attractive to the dairy farmer.

General Conclusions Current investigations indicate that 55 per cent of milk production costs is attributable to food, and a further 25 per cent to labour. Grazing all the year round offers possibilities of reducing the cost of both. No doubt, well-managed grass is the ideal food from April to October, but other plants are more attractive for the winter period.

For the small farmer (say 60 acres or less) it is doubtful if winter grazing crops should replace traditional mangolds and kale, provided every effort is made to produce very heavy crops, but even on this size of holding, it may be possible to use rape or thousandhead kale as a reseeding pioneer crop.

No critical work has been done on fertilizers—the basic dressing has been 3 cwt. of superphosphate per acre with a top dressing of nitrogenous manure when the plants are in the 3–4 inch stage. Last year, through a faulty drill, half a field (sown August 1) had 2 cwt. of nitrogenous dressing, and the other half had none.

The crop weights on December 15 were as follows:

With 2 cwt. of nitrogenous manure	12 tons per acre
With no nitrogenous manure	3 tons per acre

While the effect of nitrogen is not always so marked, there can be little doubt as to its value in obtaining a heavy crop. Rape appears to be far more resistant to mildew where a good dose of fertilizer has been applied.

PROGENY TESTING OF HILL RAMS

G. Ll. Williams, B.Sc.
University College of North Wales, Bangor

PROGENY testing is a common term in modern farming. In this article we discuss its value in the improvement of Welsh Mountain sheep.

The progeny test is simply an analysis of the breeding merit, or genetic make-up, of animals based on the performance of their progeny. It usually refers to the male rather than to the female parent, since the former is

responsible for more offspring than the latter. By this test the good, mediocre, and bad sires are brought to light so that future breeding policy can be placed on a more secure footing. The method is by no means new, for it was used successfully a century or two ago by the famous breeders. The following quotation occurs in the *Complete Grazier* by a Lincolnshire grazier, published in 1805: "The conduct of the late Duke of Bedford deserves to be imitated by every attentive breeder. Previous to drawing off any ewes for particular rams, it was his constant practice to select every ram, together with the lambs begotten by it in the preceding year, from the rest of the flock, and to confine them in separate pens, in order that he might examine them and their issue, and thus be enabled to make a proper determination."

Selection of breeding animals in this country is chiefly influenced by appearance and pedigree, and very little by the performance of the animals concerned, or their close relatives. Progress along this line is dependent to a large extent on luck, and that, like the weather, is an unknown quantity.

Recent American work has shown that the best and most reliable method of improving dairy cattle is by using high-quality proven bulls and not necessarily of the same line. The results of the New Zealand Line Survey indicate that the present level of milk production in that country can be increased only by the large-scale use of proven bulls. Prominence is widely given to the usefulness of progeny testing dairy bulls by the Ministry of Agriculture, the Milk Marketing Board, and various other authorities. Farmers are urged to milk record and to use those records when choosing bulls.

A Poultry Stock Improvement Plan was launched recently by the Ministry, and one of its chief features is a scheme of progeny testing for foundation stock breeders.

Better Sheep in a Few Generations

Bearing these things in mind, it is rather strange that one rarely hears the term "progeny testing" used in discussing the improvement of hill sheep in this country. In New Zealand, Australia and the U.S.A. a considerable amount of research has been carried out. Investigations by McMahon(1) and others showed that a good deal of the variation between sheep in economic characters is due to season and environment; for example, seasonal effects account for 50 per cent of the variation encountered in the fleece weights of a given flock. This brings to mind the old saying that half the pedigree goes in by the mouth and emphasizes the fact that one way to improve animals is to provide them with better food. "Characters of sheep are the result of complicated interactions of such characters as teeth, digestive ability, and resistance to disease, with those basic genetic factors responsible for the particular character in question." McMahon found that the parents controlled only about 10 per cent of the variation of their progeny. It thus follows that only one-tenth of the improvement made by culling is passed on to the progeny. Heavy culling of ewes is impossible in mountain flocks and, if practised, may not give any worthwhile improvement. Only a few of the rams, about 3 per cent, are required for breeding, so there is considerable scope for culling them. Selection of the best-looking ram, however, cannot result in rapid improvement, but selection of rams on the basis of their progeny will do so in a few generations, as the following table shows.

The Relative Rates of Improvement, using Different Systems of Breeding, on the Fleece Weights of New Zealand Romney Marsh Sheep
(*McMahon*)

Method of Selection	Percentage Culled	Progeny Improved *lb.*	Relative time for 1 lb. Improvement *years*
Ordinary Selection			
Culling ewes only	50	0.042	96
Culling rams only	97	0.112	36
Culling rams and ewes	97 / 50	0.162	24
Using Progeny-Tested Sires			
Progeny test 20% rams at random, keep best 3% ..		0.75	4
Culling 50% ewes; progeny test 20% rams, keep 3% ..		0.79	4
Culling 80% rams; progeny test 20% rams, keep 3% ..		0.82	4

Recent results from the Massey Agricultural College, New Zealand(²), show that the inheritance of other productive qualities in sheep is similar to that of fleece weight. "The intensity of inheritance or heritability is the similarity between the ewe and her offspring in the character being considered. When there is a strong similarity between the ewe and her offspring, it can be seen that the hereditary make-up passed on from the parents has an influence greater than the environment." Although the results apply to Romney Marsh sheep, they are applicable, no doubt, to similar breeds of sheep in this country and thus are quoted below.

Intensity of Inheritance of Fleece Characters

	per cent	
Fleece weight ..	10–15 ..	Weak
Staple length ..	21 ..	Weak
Hairiness ..	50–70 ..	Strong
Fleece quality ..	14 ..	Weak
Handle	44 ..	Strong
Lustre	27 ..	Medium

Intensity of Inheritance of Body Characters

	per cent	
Body as a whole ..	12 ..	Weak
Head	40 ..	Strong
Breed type ..	41 ..	Strong
Length of leg ..	80 ..	Very strong
Bone quality ..	58 ..	Strong
Shoulders ..	20 ..	Weak
Back	17 ..	Weak
Loin	11 ..	Weak
Hindquarters ..	— ..	Very weak

These figures show the difficulties that face breeders in improving certain characters in sheep. Improvement of weakly inherited characters, such as loin and hindquarters, is very difficult by culling methods, but is possible by using progeny-tested rams.

The foundations for scientific and reliable methods of improvement have been laid by these pioneer research workers, and it remains for us, in this country, to apply that work in our farming systems.

The position existing within the Welsh Mountain breed of sheep will now be examined.

Special Characters required in Mountain Sheep Admittedly, breeders are at times unconsciously progeny testing, for rams leaving undesirable lambs are quickly disposed of. Unfortunately, the general system of hill sheep farming in Wales makes it more or less impossible to identify each ram's progeny, for the practice is to run the whole flock of ewes with the required number of rams in a large enclosure or on the open hill. Thus, for accurate and reliable progeny testing to be carried out, it is essential to have several sheep-proof enclosures for use during the tupping season, and these are seldom numerous on Welsh hill farms. Another feature of progeny testing is that the lambs must be suitably marked and identifiable as to dams and sires, as early as possible after birth.

Large-scale progeny testing is thus out of the question for the ordinary farmer, but in view of its importance the Agricultural Research Council generously agreed to assist us financially, at Bangor, in carrying out detailed progeny testing of Welsh mountain rams.

Obstacles were encountered at the outset because of the essential features of Welsh Mountain sheep. Unlike the dairy farmer, who, generally speaking, has chiefly to consider the milk or butterfat records of the bull's heifers in determining the qualities of the bull, the hill farmer requires an animal possessing many characters, many of them obscure and difficult to define.

Hardiness is the first essential of a mountain sheep, which implies the ability to live and thrive under adverse conditions, but not, necessarily, on a starvation level. It thus follows that the shape and size of the mountain ewe is rather different from that of a lowland sheep. A large sheep with a square body and short legs would be unable to scramble in search of food over the rocky mountain slopes of scanty vegetation. The Welsh ewe is comparable in conformation with a dairy cow, having well-developed hind-quarters, a large barrel and well-sprung ribs, but the front quarters are narrow and light. One would naturally expect such a sheep to be a deep milker, and we venture to claim that, taking body weight into consideration, the Welsh Mountain ewe is outstanding in this respect.

Sheep kept under such conditions require a firm and close fleece, with plenty of "lash" in it, to protect them from the cold and heavy rainfall, as much as 150 inches a year in a few areas. A soft loose coat would be worse than useless. Some degree of kemp is found in most Welsh sheep and is generally regarded as an indication of hardiness. The usefulness of kemp is a controversial issue ; some argue that it helps to waterproof the adult fleece, but we maintain that it is chiefly connected with the type of birth coat and also with the sheep's skin thickness. Experience has shown that most kempy sheep will breed lambs possessing thick hairy coats to protect them from the cold and wet. On the other hand, it is quite likely that a non-kempy sheep *picked haphazardly* will breed lambs which, at birth, have very short, fine-woolled coats, like that of the Southdown. However, investigations at this College have shown that some lambs shed their hairy coats when a few months old and afterwards develop fleeces that remain practically free from kemp, even under severe mountain conditions.

It is possible that the quality of Welsh wool has received too much attention in the past, for, after all, it is the sheep that matters most. If we regard wool as a minor by-product and concentrate on the other characters of Welsh sheep, it is possible that the rift between breeders of kempy and non-kempy sheep will be closed at last. Provided that the lambs are born with thick hairy coats, it matters little whether their parents were kempy or not. It is possible, however, that extreme kempiness is incompatible with milkiness and the ability of lambs to fatten on lowland pastures.

Gradations between the two types of birth coats are found and, in examining the progeny of different rams, it is necessary to take account of them. A system of classifying birth coats was drawn out by Professor R. G. White many years ago, namely:

Type 1 is the thick hairy coat, uniform over the whole body.

Type 2a is almost the same as 1, but shows a little openness in the coat on the neck.

Type 2 has a clearly marked pattern, with a distinct line of demarcation at the heart girth. The body behind this line is well covered. In front of the line, there is only the short fine coat characteristic of Type 3.

Type 2c is nearly as devoid of protection as Type 3, but the hindquarters have some hairy fibres, and it is usually possible to distinguish faintly the line at the heart girth.

Type 3 has practically no hairy coat at all, except on the legs and tail.

The aim should thus be to have as many Type 1 and 2a lambs as possible, and while the inheritance of birth coats is not straightforward, there is plenty of evidence to show that rams differ appreciably in the type of lambs they sire. Unfortunately, the scope for culling ewe lambs on the basis of birth coats is limited, owing to the low lambing percentage of hill sheep and the fact that several characters must be studied at the same time. For this reason, several Type 2 ewe lambs must be retained, but all ram lambs selected for breeding should possess the Type 1 birth coat. It is interesting to note that the Type 3 lambs, provided they survive the rigours of spring, develop into better fat lambs than their rough-coated mates.

These characters, together with instinct and intelligence, contribute towards that complex thing—hardiness.

Hardiness in itself is not enough, for the hill farmer must have marketable products for sale, such as store lambs and draft ewes. While three- and four-year old wethers are still to be found in many areas, their numbers are diminishing every year.

The writer is acquainted with one old farmer who seldom sells any lambs, but keeps them until three or four years of age, when they go off in semi-fat condition.

The lowland grazier requires lambs that will fatten as rapidly as possible on aftermath or rape and turnips. It is thus futile for breeders to concentrate on extreme hardiness alone and ignore market requirements. Although early maturity is incompatible with the nature of hill sheep, and is not, therefore, to be desired, our aim should be for the lambs to be reared well on the open hill, and to fatten at a satisfactory rate when brought down to better pastures. In this respect there is evidence to show that lambs, sired by rams of good conformation, arrive at market at an earlier age and grade better than those got by very hardy rams.

Again, draft ewes must be prolific and good rearers of cross-bred lambs when kept on lowland pastures.

Thus hardiness, milking quality and ability of lambs to fatten are, perhaps, the chief requirements of Welsh sheep. In progeny testing we must attempt to record as many of these characteristics as possible, and the following list is suggested:

(1) Birth coats and birth weights of lambs.
(2) Weight of lambs at castrating, or shearing time. This should give an indication of mothering ability or milking qualities of the ewes.
(3) Rate of growth of wether lambs during their fattening period.
(4) Body weights of ewe lambs at 7, 13 and 19 months of age. These ages were chosen as they fit in with the times of collecting sheep from the open mountain. Nutrition will affect these weights considerably, but it should be possible to see the effects, if any, of different rams on the size of the sheep.
(5) Weight of lambs per ewe, or per 100 lb. of ewe per year.
(6) Fleece texture of ewes.

(7) Fertility and longevity of ewes.
(8) Thickness of skin of ewes. This character may be closely associated with hardiness and the amount of kemp in the fleece. We find considerable difference in skin thickness of our flock ewes and we seek its connection with the other characteristics of sheep. It may be that thick skins in sheep are as in the dairy cow, associated with low milk production, but with extreme hardiness on the other hand. There is little evidence, at present, to show that this is so, but it is a suggestion that we are pursuing further.

A long-term project was started last autumn at the College Farm, and some results are now available.

Work at Bangor A flock of some 650 Welsh Mountain ewes is maintained at the College Farm and is available for experimental work. The flock is managed in accordance with the usual practice of Welsh hill farmers. The ewes are wintered on the enclosed hill or "ffridd," which runs from 150 to 1,100 feet above sea level, and after shearing (mid-June) are sent up with their lambs to the open mountain (up to 3,000 feet) where they remain until the end of October. Most of the lambs are born in April and are weaned about mid-September. An attempt to do the ewe lambs well is made by sending them away to lowland farms for their first winter, while the wether lambs are fattened on the lowland of the College Farm. The percentage of lambs reared is about 80, so that practically all the ewe lambs have to be retained to maintain the numbers of the flock. Ewe lambs are never bred from, and the ewes are drafted at 4½ years old. A select pedigree flock is kept to supply rams for the mountain flock, and for sale.

To facilitate the experiment, only shearling ewes were used with the selected rams. In the absence of reliable correction factors for the effect of age on fertility, prolificacy, milkiness, etc., it is advisable to test the rams on ewes of the same age and kept under the same environment.

At tupping time, four groups of 30 ewes were picked, at random, from the shearling stock. The number of ewes used is greater than that actually required for accurate work. Most research workers agree that at least six or seven unselected progeny are necessary to give a reliable measure of the transmitting ability of a ram. In order to utilize our enclosures properly and were to allow for poor fertility and mortality on the open hill, 30 ewes run with each ram.

All the ewes and rams were weighed and earmarked, and the following observations made on the fleeces: (a) length, (b) density, (c) kempiness, (d) fineness, (e) absence from lockiness. Similar observations will be made on their progeny when ready for mating.

After a period of four weeks the ewes were run with the rest of the flock. The necessity of changing rams during the mating season is of the utmost importance, for the fertility of rams cannot be judged entirely by their action in the field.

For the purpose of the experiment the average gestation period of 147 days was taken, and only lambs born within the appropriate time were regarded as the progeny of the four rams.

All lambs were weighed, and suitably marked as soon as possible after birth, and their dams identified. Note was also taken of their birth coats. When a fortnight or so old the ewes and lambs were sent up to graze on the enclosed hill with the rest of the flock. The lambs were weighed again at shearing time. Since the age of each lamb was known, it was possible to calculate their rate of growth from birth to this date.

Particulars of the progeny of the four rams are given in Tables 1, 2 and 3.

Table 1. Birth Weight of Lambs

Ram	Weight of lambs *lb.*	*oz.*
A	6	8
B	6	10
C	6	2
D	6	8

The differences in birth weights between the four groups of lambs are small and not significant. The number of lambs involved is too small to arrive at any definite conclusion, but several workers state that little difference is found between rams within a breed. It is well known that the size of cross-bred lambs is influenced by the breed of ram ; for example, lambs by Wiltshire Horned rams from Welsh ewes are heavier than those by Southdown rams from the same type of ewes. Recent work by Wallace shows that the chief factor affecting birth weight of lambs is the nutrition of the ewe during late pregnancy.

In passing, it is worth noting that our 1948 lambs were a good deal heavier and more vigorous at birth than those of the previous season, reflecting, no doubt, the mild and open winter.

Table 2. Birth Coats of Lambs

Ram	Progeny				
	Type of Birth Coat (*Percentage of lambs*)				
	1	2a	2	2c	3
A	46.6	6.7	33.3	13.4	—
B	51.8	18.5	25.9	3.8	—
C	41.0	23.8	19.0	9.5	6.7
D	22.2	16.6	44.4	5.7	11.1
Whole Flock	51.0	20.0	16.0	4.5	8.5

Appreciable differences were noted in the type of birth coats of the four groups. Rams B and C left far better coated lambs than A and D, 70.3 and, 64.8 per cent of Type 1 and 2a, compared with 53.3 and 38.8 per cent. Ram D was very disappointing for, on the amount of kemp in his fleeces one expected a good proportion of well-coated lambs. Taking the flock a a whole, the majority of lambs born have good birth coats. This level was maintained by rams B and C, but rams A and D had too many Type 2 birth coats.

Table 3

Average Liveweight Increase of Lambs from Birth to June 12

Ram	Progeny (*oz. per day*)
A	6.0
B	5.9
C	5.8
D	5.5

The differences in liveweight increase between the four groups of lambs are not significant, but the figures indicate the uniformity of the ewes as milkers. The lambs weighed on an average between 29 and 30 lb. when eight to nine weeks old. The fact that Welsh lambs, reared on poor hill herbage, can put on nearly half a pound in weight per day up to this age, reveals the high milking qualities of Welsh ewes or, more correctly, shearling ewes.

Most of the attention in breeding is given to the ram, since he leaves a larger number of progeny than the ewe. However, one should bear the latter in mind, particularly when considering milkiness. Our results, to date, indicate the presence of several superior milkers in the experimental flock, and these should certainly be used for ram breeding in future years.

Effect of Condition on Potency of Rams A good deal of attention has been drawn to the necessity of having rams in a hard condition at breeding time, and our experiment corroborates this view. Each ram was weighed at the beginning and end of the tupping season.

Two of the rams, A and D, had been shown that summer and, in accordance with present-day custom, had been well fed and were in "excellent condition". Rams B and C, on the other hand, are rather ordinary rams to look at and were on the enclosed hill all the summer.

Particulars of the weights of the rams and the percentage of ewes that lambed by them are given in Table 4.

Table 4

Weights of Rams and Percentage of Ewes that Lambed by Them

Ram	Weight October 21	Weight December 22	Loss in weight	Percentage of ewes that lambed
	lb.	*lb.*		
A	153	123	30	53
D	139	108	31	67
B	135	115	20	85
C	122	104	18	78

The effect of high feeding is clearly indicated in the lambing figures. During the tupping season we noticed that rams B and C were far more vigorous and spent more time searching for ewes on heat than rams A and D. In this respect, well-fed rams are inferior to the rough or hill-bred rams in sex drive or the urge to mate. This point is of the utmost importance on the open hill and may, in part, account for the rather low lamb crops in many hill flocks. Note should therefore be made of the general behaviour of rams when subjecting them to a progeny test.

Summary Difficulties encountered in the progeny testing of hill rams have been discussed and ways of overcoming them suggested.

Four rams were each tested with 30 shearling ewes last year and the results, to date, have been presented.

No significant differences were noticed between the progeny of the four rams in birth weight, or in liveweight increase from birth to eight weeks of age. The uniformity of the ewes as milkers is indicated by the results, but several were superior milkers and should be used for breeding ram lambs.

Differences were noted in the birth coats of the four groups of lambs, two of the rams maintained the flock average, while the other two left too few good-coated lambs.

The necessity of having rams in good working condition at tupping time was clearly demonstrated by the experiment.

Spectacular results cannot be expected at once from progeny testing, but, taking a long-term view, it is the only reliable way in which we can improve or even maintain the present quality of our flocks of hill sheep.

References

1. McMahon, P. R. Proceedings of the Ninth Annual Meeting of Sheep Farmers, Massey Agricultural College, New Zealand. (1940).
2. Rae, A. L. Proceedings of the Tenth Annual Meeting of Sheep Farmers, Massey Agricultural College, New Zealand. (1947).

TAKE-ALL OF CEREALS IN ENGLAND AND THE EPIDEMIC OF 1948

W. C. Moore, M.A.

Ministry of Agriculture and Fisheries Plant Pathology Laboratory, Harpenden, Herts

It is no exaggeration to say that Take-all was more widespread and destructive in England in 1948 than it has been at any other time since the disease was first recognized here some thirty-five years ago, and it naturally gave rise to much concern among farmers. Fortunately, thanks largely to the patient researches carried out by Dr. S. D. Garrett at Rothamsted Experimental Station during the past ten years, it is possible to give a satisfactory explanation of the epidemic and to reassure farmers about the immediate future.

Fungus survives on Stubble Residues and Weed Grasses To understand the varying significance of Take-all from season to season, it is necessary to know a little about the disease and about the main factors which affect its development. Take-all is caused by a fungus which survives in the soil from one year to the next only in infected stubble residues and on the roots of certain grasses, notably couch, Yorkshire fog, creeping soft grass (*Holcus mollis*), and bent. Thus, provided weed grasses are kept down, the fungus will disappear from the soil as the stubble residues rot, and under favourable conditions that process is completed in about a year. Consequently, a one-year break from wheat and barley is normally as effective in checking Take-all as continuous cropping with wheat and barley is in promoting it.

When the fungus is present on stubble residues or weed grasses in a soil sown with wheat or barley, it finds its way to the roots of the seedling wheat or barley and begins to travel along them towards the crown of the plant. From this stage onwards there is a constant underground struggle between the fungus and the plant, in which the important factors are the rate at which the fungus travels along the roots, and the rate at which the plant is able to produce fresh roots to replace those destroyed by the fungus. If the fungus gets the upper hand early enough, the plants remain stunted and yellow, fail to produce ears, and may be killed outright—the true Take-all stage. If—as usually happens in England—the struggle is more prolonged, the fungus does not reach the crown until relatively late, the plants come into ear, and the white, bleached ears with shrivelled grain, characteristic of the "whiteheads" stage, become prominent in the crop.

Experimental work has shown that the fungus travels along the roots more quickly when the soil is of a light texture, alkaline, moist and warm, and that liberal manuring with nitrogen, phosphorus and potassium (NPK) promotes root growth and so increases resistance of the root system to infection. Practical experience confirms the interplay of these different factors. Thus the light-textured, alkaline soils of the Yorkshire and

Lincolnshire wolds, the East Anglian ridge, the Chilterns, the chalk downs of Hampshire and Wiltshire, and the Cotswolds are the chief danger areas for Take-all in this country. It was from these districts that the disease was mostly reported in pre-war days, when rotations were normal and when about one year in five was a Take-all year. In the ten-year period 1933-42, for instance, Take-all was severe in two years, moderate in five, and slight in three. On the whole, severe attacks occur after a mild winter and a wet spring, during which the fungus is active on the roots, while little is seen of the disease after a cold winter, provided the spring and early summer months are relatively dry.

The more continuous cropping of cereals during the 1939-45 war soon increased the risks of loss from Take-all, and the striking effect of the narrowing rotation is obvious from the fact that during 1943-48 three of the six years, or one year in two, were Take-all years. But among them 1948 was outstanding. Not only were there widespread and severe attacks in wheat and barley in the usual danger areas, but the disease gave rise to much concern among farmers considerably farther afield. Moreover, Take-all was frequently reported on land where wheat and barley had not been grown the previous year, and this is quite unusual. Indeed it was only in the extreme north of England and in Wales* that conditions were more or less normal. The fact is that for two successive years there was a sequence of circumstances favourable to the development of the disease.

This Year's Epidemic and Black Mould The origin of the epidemic may in part be traced to the wet summer of 1946 (when Take-all occurred widely) and the severe winter that followed. Stubbles were not ploughed under until late in the spring of 1947 or, if they were, the stubble residues remained frozen and unrotted in the ground. The cold winter was followed by a hot, dry summer with very dry soils, and in many districts the stubble was still unrotted when autumn sowings began. This virtually nullified the effect of a one-year break and accounted in the main for the appearance of Take-all in 1948 in crops on land where no wheat or barley had been grown the previous year. The favourable autumn of 1947 led to early planting while the fungus was still active in the stubble residues, and the mild winter that followed permitted active growth of the fungus along the seedling roots. The balance was again thrown in favour of the fungus by the exceptionally heavy rains of January, 1948, when much of the nitrogen was leached out of the soil and root growth was retarded. It was restored a little by dry weather in early spring, which checked fungus growth along the roots and helped to prevent a general occurrence of the true Take-all symptoms. With the onset of wet conditions, however, the fungus renewed its activity, and well before harvest the "whiteheads" stage was very prevalent in most parts of the country. The culminating feature which produced widespread and, truth to tell, unnecessary alarm, was the development of Black Mould on the bleached ears just before harvest. Black Mould is always apt to develop when the weather is wet in August and September, even on otherwise healthy ears, though it is commoner on defective ears. It is not a Smut or an active parasite, and, if the crop is otherwise healthy, it will have no adverse effect on ripening or germination of the grain : nor is it a cause of thinning-out or deaf ears. Indeed ear blackening should be

* The Take-all that occurs on oats, barley and wheat in Wales and part of north-west England is caused by a distinct variety of the English Take-all fungus, and this form of the disease was not more prominent than usual in 1948.

regarded, not as a disease, but as a sign that the crop has been affected, probably for a long time, by some entirely different trouble, which has led to the production of defective ears. In other words, Black Mould is a result and not a cause of disease. The primary cause is often Take-all, but it may also be some other fungus disease, or merely malnutrition.

This, then, is the broad picture of Take-all in England, with particular reference to 1948. It shows that the exceptional prevalence of the disease during the past season was primarily due to an unusual combination of circumstances which extended over two years and were nearly all favourable to the disease, and which are unlikely to recur for many years. It also reveals quite clearly the possibilities of the disease under continuous cropping with cereals, especially in the danger areas, as well as the importance of a one-year break from wheat and barley at least every two or three years: and incidentally it implies the uselessness of making a break in the rotation to starve the fungus out of the soil, if susceptible weed grasses are allowed to grow and carry the fungus over the break. There is clearly no reason to expect a recurrence of the epidemic in 1949, especially if due precautions are taken with regard to adequate rotation and grass weeds.

Take-all is not seed-borne and there need be no hesitation about using seed grain harvested from an affected field. Oats are immune from attack by the English variety of the Take-all fungus and can safely replace barley in the rotation if cereals must be grown. Early ploughing in of stubble leads to more rapid rotting of the residues, and a firm seedbed for the next cereal crop helps to hamper the growth of the fungus along the roots. Generous top dressing with sulphate of ammonia not later than March assists the plant in its struggle with the fungus, by maintaining a readily available food supply, and phosphate should be given to encourage root growth when a second or third consecutive cereal crop is being grown.

HARVESTING SUGAR BEET

RECENT DEMONSTRATIONS

H. J. Hine, B.Sc. (Oxon)

Ministry of Agriculture and Fisheries

THE Sugar Beet Research and Education Committee of the Ministry of Agriculture and the Department of Agriculture for Scotland have always fostered the development of machinery for sowing, cultivating and harvesting sugar beet.

Many years ago, when I was a student assistant at the field station of the Oxford Institute for Research in Agricultural Engineering, one of my first jobs was the hard one of helping to dig, top, and carry the beet from a plot which we had failed to harvest by the machines we were experimenting with. Much progress has been made since those days in the mechanization of all stages of sugar beet production, and many of the latest developments in harvesting and handling were shown in the third Annual National Demonstration of Sugar Beet Harvesting Machinery, organized on behalf of the Sugar Beet Research and Education Committee by the British Sugar Corporation and the National Agricultural Advisory Service, at Marquess Townshend's Manor Farm, Fakenham, Norfolk, on October 21 and 22, 1948.

In this demonstration the machines, some made in Britain and some imported, some newly developed and some well tried, were put to work, in favourable soil conditions, in a 36-acre field of growing beet. Other

demonstrations were held in Sussex on October 1, Herefordshire on October 5, Essex on October 9, Lincolnshire on October 27 and 28, and in Perthshire on November 4.

Multiple- and Single-Operation Machines The performance of the various machines emphasized once again the truth of the dictum, true in agricultural engineering as in all other kinds of engineering, that although a machine to perform a single operation may be invented, developed and perfected quite quickly, the development of a complicated machine to carry out several operations simultaneously is a slow, difficult task. At least one British firm has carried on steadily with detailed improvements to its design for a complete harvester, and the makers this year were rewarded by seeing their machine work steadily up and down the field with the same kind of reliability as a combine grain harvester. This particular machine works not only reliably but very accurately. The topping is determined precisely by a creeper track which acts as a feeler guide for height. In previous models of this make of machine the cleaned beet are held in a hopper and discharged in a windrow. This year in addition to the standard model, a machine was shown with an adaptation to deliver the beets to a trailer running with the machine.

At the other end of the scale, Danish machines, each designed to do only one part of the harvesting operation, did remarkably good work at the Norfolk and Lincolnshire demonstrations. One machine, made in models for dealing with either a single or double row, tops the beet while they are still in the ground. Both models can be drawn by horse. The height of the topping blade is regulated by a notched wheel acting as a feeler, and the height control is so sensitive that the topping of the crowns is carried out with great accuracy, even when the crowns of the roots are at irregular heights.

Two machines to lift previously topped beet were shown. These deal with only one row at a time and can be drawn by horse or tractor. On one machine lifting prongs take the beet into a cylindrical cage ; on the other model a small spinner knocks the beet into the cage, which rotates as the machine moves forward, cleaning the roots and delivering them into a dumping basket. In one model the operator sits at the back of the machine and steers the outfit by a motor-car type of steering wheel, and he can empty the dump basket at the required intervals. With another model the operator walks behind the machine.

A pair of machines for topping the roots and then lifting them in separate operations is being made in Britain from designs prepared and developed in Sweden. These British-made machines were at work at the Sugar Beet Corporation's Demonstrations this year.

A great advantage of these separate machines over some complete harvesters is that between the first operation of topping the beets and the second of lifting the roots, the beet tops can be collected fairly free from dirt and fed to stock directly or ensiled.

Some American machines, though complete harvesters, are, however, designed to conserve the tops by putting them into a separate windrow for picking up clean. One of these American machines, not built on a separate chassis as are most complete harvesters but mounted directly on to a tractor, is designed as a one-man outfit. The tractor driver is able to control all parts of the operation, and the tops are laid in a clean windrow.

This method of mounting the harvester directly on to the tractor is used in another American model, which allows hand workers to assist part of the operation. The driver has a clear view of the beet and controls the topping device by a handle which gives auxiliary regulation to the "finding" device of the topping disc. The beet tops are taken off the cutting disc

by moving fingers which throw them against a canvas curtain, causing them to drop into a windrow. The roots, when topped and lifted, pass to an elevator which takes them on to a belt running over the side of a bin. Two or more men standing beside the belt pick the beet off the belt and drop them into the bin. These men can top by hand any beet that the topping disc misses. Stones and rubbish are left on the belt and so dropped over the edge of the bin on to the field. When the bin is full an automatic device causes the elevator to empty the bin on to a trailer brought alongside the machine. An alternative arrangement controls discharging by hand, so that the beet can be tipped out at a clamp.

Possibilities of Extended Use A complete beet harvester is necessarily an expensive machine, and growers of small acreages ask themselves whether they are justified in spending so much money on equipment that cannot be used for any other purpose than beet harvesting. It is therefore interesting to note that the components of one of the British-made harvesters demonstrated this year are arranged so that the elevator part can be used as a loader for filling lorries from clamps at the roadside or on the edges of a field. Two other British makes of harvester are, by the addition of inexpensive attachments, being tried for harvesting potatoes.

Such extended usefulness is important, for anything that increases the period over which a machine can be worked per season reduces the cost of mechanization.

By arranging these annual demonstrations of all available machines for harvesting and handling sugar beet, the Sugar Beet Research and Education Committee and the British Sugar Corporation are serving the interests of food production in hastening the development of harvesters, and individual farmers are greatly helped in their difficult task of deciding which of the machines is best suited to the circumstances of their own farm.

ENGINE CARE: No. 2

C. G. Bainbridge, M.I.Mech.E.
Barnstaple, N. Devon

It is commonly found that a tractor engine rarely receives the care and attention which is lavished on a car engine, and yet the average tractor probably does three times as much work in a year as the average car, and under less favourable conditions. It is the little attention, methodically and regularly given, which keeps an engine in good condition and a high state of efficiency.

Neglect of attention to those adjustments which become necessary from time to time, or to the rectification of sundry minor defects which occasionally arise, the use of inferior or insufficient lubrication oil, or failure to change it regularly, are perhaps small items in themselves, but they may have considerable influence on the power output and smooth running of an engine, and will certainly reduce its life.

Admittedly, very often the parts requiring adjustment and attention are those which are not seen, but this is no excuse for neglecting them. The engine user should study the makers' instruction book in order to become familiar with the internal construction of the engine and the location of those parts which ought to be attended to periodically.

The following notes are intended as a general guide to those points requiring periodical maintenance, occasional inspection and, if need be, adjustment, in order to maintain an engine at the highest point of efficiency.

The Cooling System Always use clean, soft water, rainwater, if possible; avoid hard, dirty or salty water. Hard water contains lime and is liable to leave deposits which build up in the water-jackets and other water passages, eventually choking them and causing overheating. For this reason, hard water is particularly undesirable for radiator-cooled engines.

If only hard water is available, it should be softened with a water softening compound; otherwise the water-jackets, etc., must be cleaned out at regular intervals by adding a handful of common washing soda to the cooling water. The engine should then be run for a day, after which the cooling system should be drained, washed out and refilled.

Similarly, dirty water will deposit mud in the water-jackets and passages and impair the cooling efficiency; it may also prevent the thermostat valve (if one is fitted) from seating, and so interfere with its function. In any case the cooling system should be drained occasionally, in order to remove any accumulated sediment. This should be done immediately at the end of a run, when any sediment will be in "suspension" and will flow out with the water. When the engine is cool wash out the system by putting a hose into the upper water connection and allow the water to run through the drain plugs until it comes out clear. Incidentally, it should be remembered that on radiator-cooled engines there are usually two places to drain: one drain plug or tap in the bottom of the radiator, the other on the side of the cylinder water-jacket.

The air spaces in the radiator must be kept clear of dust, mud and other obstructions, otherwise the radiator may overheat. Where flexible hose connections are provided on tank and radiator pipes, keep the hose clips tight.

Avoid Overheating The water level in tank and radiator-cooled engines must always be maintained above the level of the entry of the top pipe (from the engine) into the tank or radiator, otherwise there will be no circulation and the cylinder block will overheat, with detriment to the engine.

Hopper-cooled engines should not be overfilled, otherwise the water will splash over into the engine: a flat piece of wood floating on top of the water will prevent splashing. As the water boils away, fresh water should be added; do not allow the water level to fall so much that the cylinder head is exposed.

Fan Belt On radiator-cooled engines the fan belt needs occasional inspection and adjustment since, if it is too slack or greasy, it will slip and thus the fan will not be driven at the correct speed and over-heating results.

Adjustment is usually provided, e.g., by an adjustable flange on the top pulley, or by a movable top bearing or bracket; there are removable

distance pieces or shims between the pulley halves on some tractors. Tighten the belt only enough to take up the slack and prevent slip; a tight belt strains and wears itself and the bearings.

WATER PUMP Some pumps are of the packingless type and need no attention except proper lubrication. With packed pumps, the packing gland should be just tight enough to prevent water leaking.

It is essential to use a proper heat-resisting water-pump grease; ordinary grease is liable to melt at high water temperatures and clog the small water passages in the radiator. The grease cup should be screwed down half a turn after every half day's work.

Valve Maintenance (Four-stroke Engines) The clearance between the end of the valve stem and the operating gear is provided to ensure that the valves are always pulled on to their seats by the springs. No clearance means that the valves will not seat, resulting in loss of compression and power: too much clearance prevents their opening sufficiently and leads to loss of power. To ensure full power, economy and easy starting, correct clearance must be maintained at all times.

The recommended clearance for inlet and exhaust valves may be different, and varies with different makes of engines—that for the exhaust usually being greater than that for the inlet, to allow for the great expansion of the exhaust valve stem, due to its higher working temperature. The makers' recommendation should be followed: some recommend making the adjustment when the engine is hot; others specify the clearance when cold. On multi-cylinder engines the clearances should be uniform throughout.

Normally no adjustment should be needed between de-carbonizings, but with new engines the clearance is liable to lessen as the valves "bed in" and when the cylinder head nuts are tightened down. It is desirable, therefore, to check the clearance on a new engine after 25 to 50 hours running. To make the readjustment, refer to the instruction book and see what the manufacturer recommends.

The adjustment must, of course, be made when the valve is closed; to make sure of this, crank the engine until one valve is fully open, then the other is sure to be closed. On petrol and paraffin engines the cranking will be easier if the sparking plugs are removed.

With side valves the means of adjustment is on the tappet: with overhead valves it is usually on the rocker arm. Special thin spanners may be needed for adjusting side valves, but an ordinary screwdriver and spanner are generally suitable for overhead valves.

The clearance is measured by inserting a feeler gauge, of the correct thickness, between the end of the valve stem and the face of the rocker arm, or tappet, as the case may be; the feeler should slide easily, without forcing or slackness, between the faces. If a set of feelers of various thicknesses is being used, check by trying the next thicker gauge feeler; if that passes between the faces the clearance is obviously too great and must be reduced. After the clearance has been set, take care to hold the adjustment while the lock nut is securely tightened, then check the clearance again to make sure that it has not altered.

With Ford and Fordson engines, no adjustment is provided and the clearance can be altered only when the engine is dismantled (e.g., for decarbonizing) by removing the valve and by grinding the end of the stem until the correct clearance is obtained.

On some engines the valve stems do not normally receive adequate lubrication and tend to work dry: it is a good plan, therefore, after the

clearance has been adjusted, to squirt some thin oil on to the exposed part of the stem. This will help to prevent the valves from sticking.

The Ignition System :
PETROL AND PARAFFIN ENGINES

Most ignition troubles are due to neglect of periodical attention and simple maintenance, such as general cleanliness of contacts and plug points ; keeping magneto, wiring and plugs dry ; to careless or ignorant adjustments, or failure to make replacements or renewals of sundry parts when it becomes necessary.

PLUGS Clean and adjust periodically. To adjust, bend the side electrode only. The gap between the central electrode and the side point, or points, should be 0.025 inch to 0.03 inch. On multi-cylinder engines adjust all plugs to the same gap ; it is difficult to estimate the correct gap by eye, therefore a feeler gauge should be used. Every engine user should possess a set of these gauges, as the thinner ones are necessary for valve tappet adjustment.

Some plugs may be dismantled for cleaning ; by unscrewing a lock nut, the central electrode and insulator may be removed from the body. Where there is no lock nut to be seen, the plug is not generally suitable for dismantling and can be thoroughly cleaned only in a proper plug cleaner ; a good garage generally has one.

Plugs gradually deteriorate and when the central electrode becomes deeply pitted it is best to discard the plug and fit a new one, otherwise starting troubles (due to poor spark) and pre-ignition (due to the thinness of the electrode) may be experienced. When dismantling or removing plugs with porcelain electrodes, use the spanner carefully because the porcelain is easily broken. It is a good thing to keep two sets of plugs and change them monthly, the spare set being thoroughly cleaned and adjusted between changes.

When replacing plugs always obtain the type recommended by the manufacturers of the engine ; many engine users do not appreciate the importance of using the correct type of plugs, which are generally classified according to their heat characteristics. Some engines need "cold" plugs, others "hot" plugs, and there is often considerable difference in performance between the various types. If the plug is too "cold" it will collect carbon and oil up (if the engine is old) : if too "hot" the points will burn away quickly.

PLUG LEADS Keep dry, free from oil and away from exhaust manifold and other hot parts of the engine. Renew when rubber is perished or damaged.

MAGNETO Always keep the magneto dry ; moisture on the outside of a magneto may penetrate to the windings and break down the insulation in time. If at any time it is suspected that a magneto is damp, it may be dried by placing it in a warm spot or oven for five or six hours. Do not bake or overheat it, otherwise the insulation will be affected ; only gentle heat is required.

CONTACT-BREAKER The contact-breaker must be kept spotlessly clean ; when the contacts are closed the faces of the "points" should meet uniformly. If they are dirty, pitted, or meet irregularly, they may be cleaned or dressed with a very fine file or hone obtainable for this purpose, or with a piece of fine oilstone. If neither is available, fine

emery cloth, on a flat piece of stick, will clean the faces, but will not be sufficient to dress them if pitted or misshapen. Do not use an ordinary file. Keep the contact faces dead flat, and be sure to clean away any dust or filings when the work is finished. If the contacts are badly worn or pitted they should be renewed, and it is advisable to renew both contacts at the same time.

The gap should need adjustment only at long intervals ; use a feeler gauge of the thickness recommended, which will be from 0.012 inch to 0.02 inch, according to the engine. A spanner with a gauge attached is often supplied by the makers. Crank the engine until the points are fully open ; on magnetos fitted with impulse starter the engine usually stops with the points closed. To open them remove the plugs and crank the engine slowly until the impulse "clicks," then turn the engine backwards—with the fan belt or flywheel—until the points are seen to be fully open. (Note that most tractor and many stationary engine magnetos run anti-clockwise, as seen when looking at the contact-breaker.)

DISTRIBUTOR (MULTI-CYLINDER ENGINES) The inside of the distributor, particularly between the electrodes, should be cleaned occasionally with a rag moistened with a few drops of petrol. "Tracking" or a burnt path between electrodes is usually caused by excessive spark plug gap. The outside of the casing, especially between the high tension lead sockets, should also be kept clean.

Take care not to damage the carbon brush or its spring, and see that it works freely and is clean ; if considerably worn it should be replaced.

SLIP RING AND PICK-UP (SINGLE AND TWIN CYLINDER ENGINES) On single and twin-cylinder engine magnetos, the slip ring and H.T. pick-up should be cleaned from time to time. By removing the pick-up, a piece of cloth may be inserted through the pick-up hole and the ring cleaned by turning the engine slowly. The pick-up brush should work freely, the end should be clean and, if badly worn, replaced.

MAGNETO LUBRICATION Most magnetos are packed with lubricant before they leave the factory, and need no further lubrication at any time. Where oil cups are provided apply a drop or two of thin machine oil every three or four weeks, or after 50–60 hours running. On no account over-oil ; more harm will be done by over-oiling than under-oiling.

On many magnetos the contact-breaker cam is lubricated by a felt pad. This pad will need re-lubricating about every 1,000 hours of service ; to do this, work into the pad a good stringy grease, such as a summer grade transmission grease. Do not use ordinary grease. If there is no felt pad the cam should be very lightly smeared with grease every four or five weeks.

The rocker arm should move on its pivot without stickiness ; a spot of grease or a drop of oil on the end of the pivot pin occasionally will be sufficient lubrication. Take care to prevent any oil reaching the contacts.

IMPULSE STARTER The impulse starter will need lubricating with thin oil occasionally. If it shows signs of not engaging or disengaging readily, the trouble may be due to dirt clogging the mechanism, or the use of too thick a lubricating oil. This may be remedied by washing out with paraffin (taking care not to allow any paraffin to reach the magneto) and then refilling with the correct grade of thin oil.

THE WHEELWRIGHT

JAMES WHITE
Rural Industries Bureau

ALTHOUGH the wheelwright can perhaps show an ancestry of over three thousand years, he cannot boast the antiquity of the potter, the weaver, or the cleaver. But when he rolled his first wheel down some ancient track he can claim that he laid the foundations of our mechanical age. About the same time perhaps the first smith watched a pool of molten metal ooze from his hearthstone. In the course of time these two craftsmen entered into a partnership which has helped man to extend his control over his environment. By applying the principle which the wheelwright discovered, the modern engineer can produce in one aeroplane as much power as the whole concerted effort of the population of Europe could exert in the Old Stone Age. Although the ancients did not fully recognize the significance of what they had invented, they knew it had qualities beyond their present comprehension. The wheel became a symbol of mystery, of change and of eternity ; fortune took it as her own device.

With the crude wheel began man's quest for ever faster locomotion, and slowly the wheelwright perfected its making. In doing so he gained a great knowledge of wood—the material on which he so long relied—and how to use its varying properties to the best advantage.

The Horse and the Tractor The heyday of the wheelwright may be over. Gone are the days of the rolling stage coach, the dignified landau and the gay phaeton. But the day of the wheelwright is by no means done. There is still a place on the farm for the horse and cart ; not the former exalted place, which has been taken by the power tractor and the rubber-tyred trailer, but nevertheless a real, if modest, place in modern agricultural economy. Where there are hard roads and firm ground the trailer is undoubtedly best for the longer hauls. But short distance carting is still a very big item in farming today, and for this the horse and cart is often more economical. On many farms crops and dung have to be carted over deeply furrowed fields or heavy ground which cattle and the winter rains have quickly turned to mire. Here the horse and cart with its axle high above the mud comes into its own. In the fenlands, where farms are often reached by long droves, the wooden wheel is the only insurance against a fatal slither into bog or dyke. Both on the farm and in the town the horse-drawn cart is better suited to jobs which involve much stopping and starting.

Many farmers consider it an economy to employ a horse on the farm, others find that their farms are too small to use a tractor economically and one or more horses are kept. Where a farmer has both tractor and horse he thinks twice before he starts up his tractor and leaves his horse standing idle in the stable or soliloquizing in the paddock. Also a cart made by a good wheelwright requires very little maintenance and will usually last a lifetime.

The wheelwright then, although he no longer enjoys the limelight, continues to provide an important service to the farmer. He makes some carts in the traditional way and he repairs many more. Between whiles he will build a trailer or a caravan, make a ladder or a hen-house and perhaps fit a utility body to a jeep. As a result his day is usually very full and he could do with more young men to help him.

The Wheelwright's Skill To all these tasks he brings a wealth of knowledge which has been accumulated by generations of craftsmen practising his trade. His appreciation of wood is deep and intimate. In cart-making his constant concern is to combine strength with lightness, to find the best wood in shape and quality for each part and to make the best use of his stocks of timber. Much of the wheelwright's capital is locked up in the timber which is stored while it seasons. The oak or elm for his hubs may lie in his shop seven or more years; the ash or elm for the felloes, which form the sections of the rim, and the oak for the spokes must also be well seasoned. The good wheelwright will know exactly when his timber is ready for use, which shakes are good or bad, and how the natural curves of the wood can be used in the cart's construction. As each load of wood comes into the yard, he will be on the look-out for a piece with the natural curve of a shaft or a long straight length for a ladder. Like a tailor with his cloth, he must get the best use out of all his material.

To do this he carries in his mind's eye the measurements of all his products, for he is not a man who usually works from exact scale drawings. From years of experience he will know the precise proportions of a tip cart so that the load will slip easily from the tapered body, or just how to construct the floor of a dung-cart so that the fork or shovel will glide easily over the boards when they are all laid lengthwise. He will know the right type of cart for particular jobs and the size of wheel for the local soil. In many cases a farmer will want a particular modification to suit his own purpose. The traditional lore of the wheelwright has equipped him to cope with all demands.

All this is not to say that the wheelwright is wedded to the past. In a modern wheelwright's shop new power-driven tools take their place with the axe, adze and draw-knife. The felloes, which an apprentice used once to spend many laborious hours in making, are now cut out by the power-band saw in as many minutes from the baulks of bitter elm. Likewise the hub of close-grained elm now revolves on a power lathe from which shavings in a great arc fly across the workshop as the wheelwright works it into shape. The power tools take the drudgery out of the work, but the age-old skill of hand and eye still controls their operations. In a practised hand there is no loss of craftsmanship and a great saving of time. For the wheelwright, like every creative worker today, hears at his back "time's winged chariot hurrying near"—as if he were being pursued by his own invention. Modern economics demand that he should produce quickly, and his traditional judgment and pride in his work tell him that he must produce well.

His Place in Rural Economy During the years of agricultural depression between the wars, the wheelwright fared badly. Farmers had little money and could not spend much on repairs or new vehicles; so the wheelwright's business declined. Young craftsmen found other jobs, and when an old man died the doors of his shop often closed for good behind the cart which bore him to his grave. But Fortune's wheel turned sharply in the autumn of 1939: agriculture became synonymous with survival. More carts were wanted; old wagons were brought in for repair; vehicles needed adapting for use on the farm; and countless other products of the wheelwright were in constant demand.

The wheelwright was overwhelmed. Often neither his tools nor his workshop were adequate, and he needed expert advice on the lay-out of his shop so that he could work as efficiently as possible. He needed suitable

power tools for his particular type of work and he often needed money to buy the tools and to extend his workshop. This work of fitting the rural wheelwright for his place in modern agriculture was undertaken by the technical staff of the Rural Industries Bureau, and financial assistance was given from the Rural Industries Loan Fund.

In this way many wheelwrights are able to keep pace with the times. Magnificent as are his traditional wagons with their stately lines—the outcome of the practised hand and eye of generations of craftsmen—the wheelwright had to turn to new requirements. His wagons were still wanted in smaller quantities, so that he could not discard them. But a new type of vehicle was needed that raised problems of design to which he could not apply the old techniques such as dish, which gave the wooden wheel its strength and the cart manœuvrability, or draw-shaving the timbers so that the cart assumed those graceful scolloped lines and lost about 12 per cent of its weight and none of its strength. From the problems of a slow-motion horse-drawn vehicle, the wheelwright with his modern equipment turned to the adaptation of vehicles for the mechanized farm.

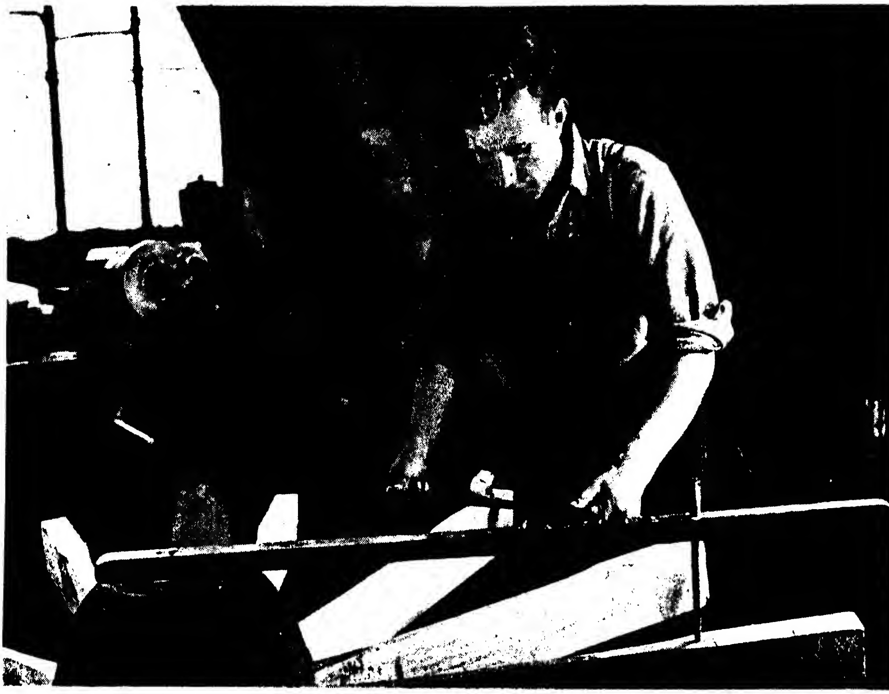
His Service to the Farmer In the Vehicle Builders' Association the wheelwright takes his place in organized labour as the craftsman who provides the farmer with a doorstep service. His traditional ingenuity and knowledge of materials should enable him to give the farmer that individual "tailor-made" service in making new vehicles and adapting existing ones which standardized heavy industry cannot provide. His long-standing cooperation with the blacksmith, who makes the ironwork for carts and assists in the intricate and spectacular art of tyring a wheel, can be extended to a profitable partnership in more modern vehicle building; for, like the wheelwright, the blacksmith, with similar technical help from the Bureau, is becoming an agricultural engineer with up-to-date equipment for welding and cutting metal.

There is still much to be done before every wheelwright can work satisfactorily in the new sphere of tractors and trailers. There are new stresses and strains and higher speeds to be reckoned with, new types of traction and new techniques. By means of his Association and the technical service of the Rural Industries Bureau, and not least by his own training and initiative, the wheelwright is both coping with the problem of mechanization and fulfilling the ancient need for sound horse-drawn carts

The local wheelwright is worth watching. He needs the cooperation of the practical farmer and he needs energetic young men to help him with his new equipment and his new problems. There is much to be said for an independent workshop in the countryside and a job where ingenuity, skill and mechanical knowledge can be combined. And there is a satisfaction in seeing the finished article roll out of the yard to take its place on a neighbouring farm and in knowing that it was created from start to finish by one's own hands.

(Photo, *John Tarlton*)

An Essex wheelwright at work with an adze on a large wheel.

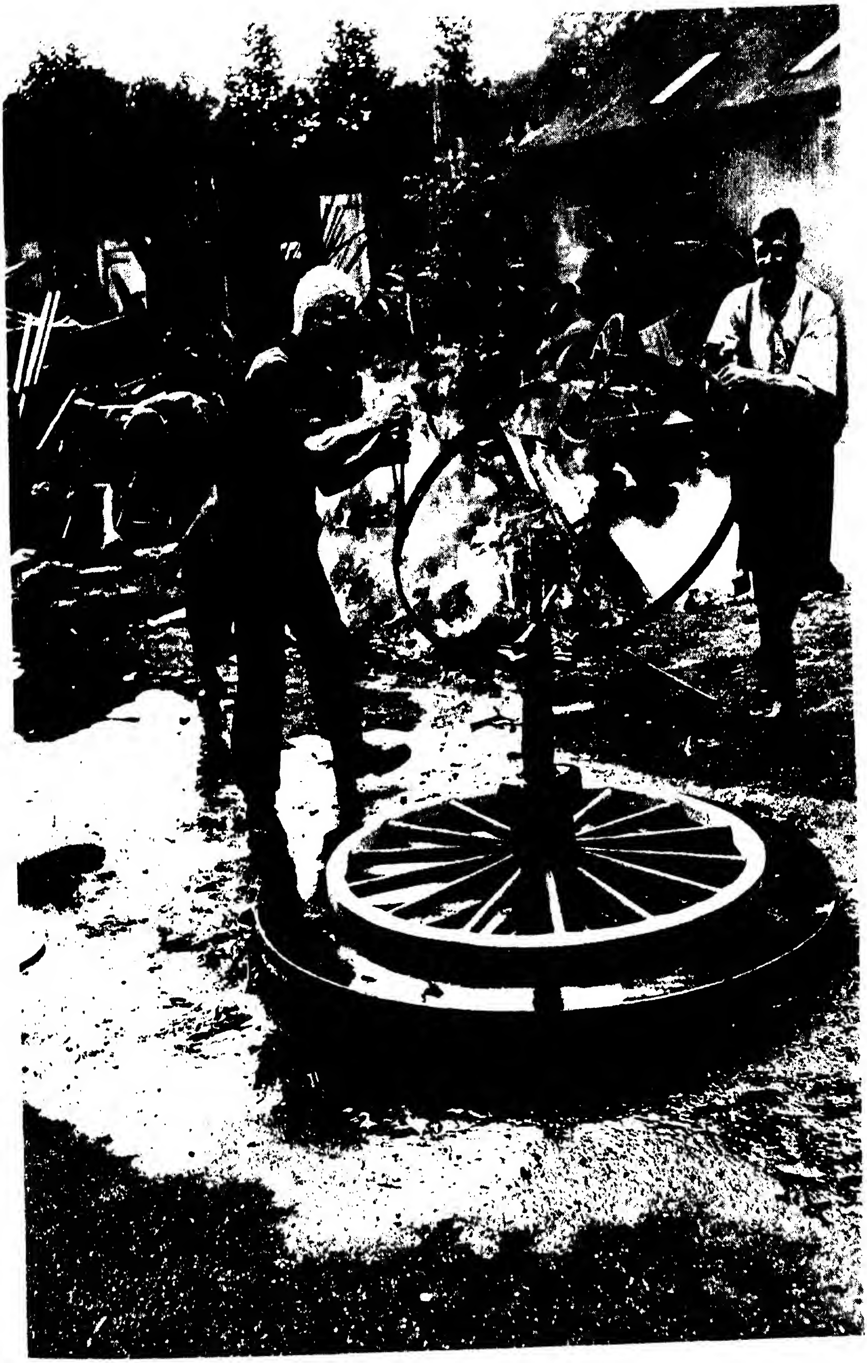


(Photo: *Rural Industries Bureau*)

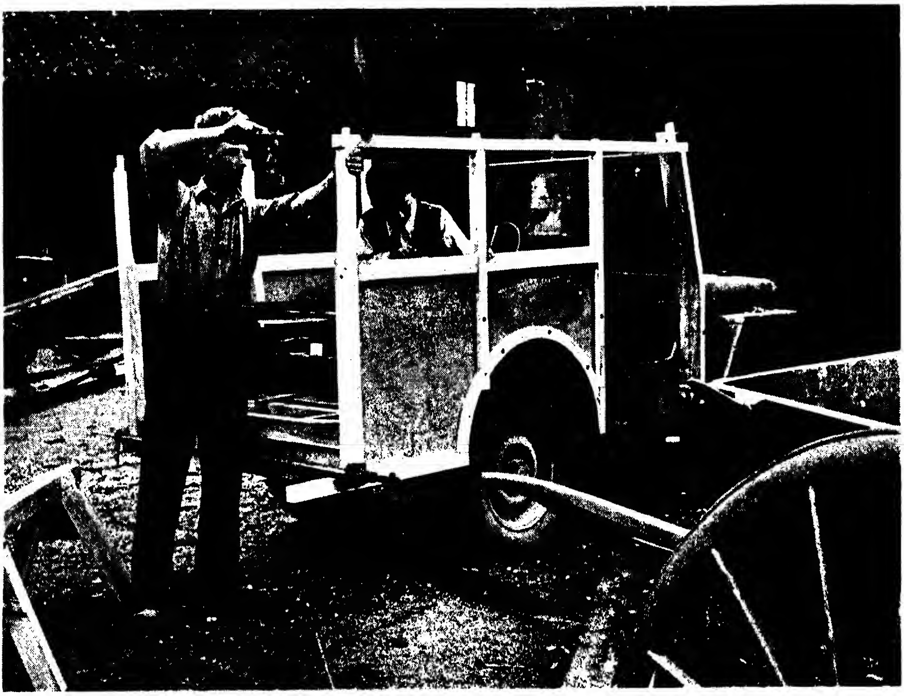
Paring the ends of a wheel spoke with a draw knife.

(Photo, *Topical Press*)

The felloes are fitted in sections, and a spoke-dog used to draw the spokes to the felloe.

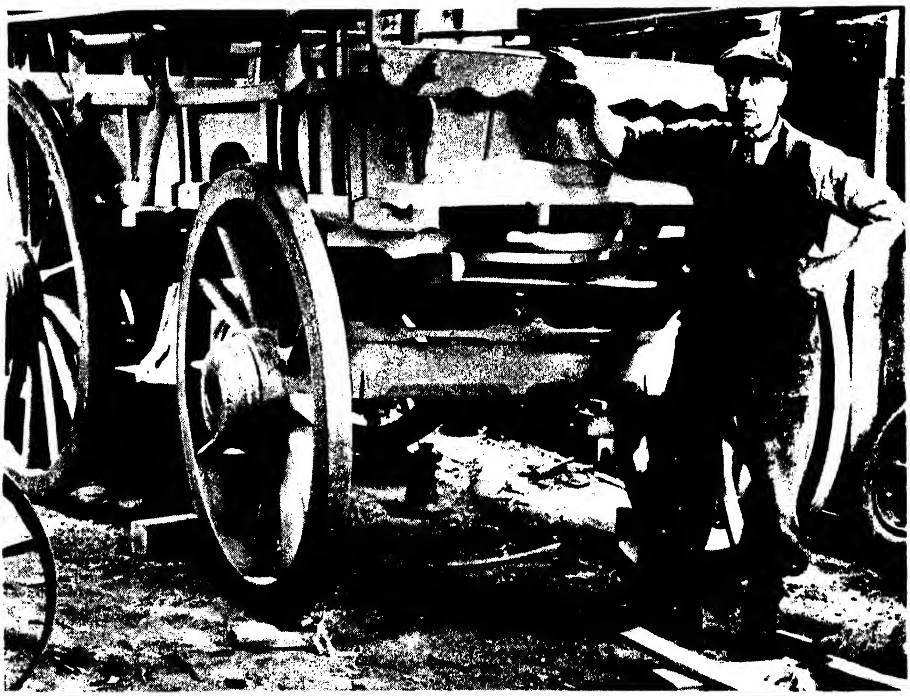


A complete wooden wheel is placed on a platform. The steel tyre rim is heated, brought from the fire and placed in position round the wheel. After being hammered into place, water is poured on to it causing the tyre to contract and draw the whole wheel tightly together.



(Photo, *Rural Industries Bureau*

Building a utility body on to a jeep.



(Fox Photo.)

Another Essex wheelwright with a fine specimen of his craftsmanship, constructed during the winter months.

FUEL SUPPLIES AND THE GLASSHOUSE GROWER

L. G. Bennett

Department of Agricultural Economics, University of Reading

THE level of output of coal has given some cause for anxiety on the part of the Government, industrialists, and the domestic consumer. This anxiety must, in turn, enjoin the strictest economy and efficiency in the use of all forms of fuel, solid and liquid. Agriculture and horticulture are together estimated to consume 1,328,250 tons of solid fuel a year(1), quite apart from the consumption of liquid fuel estimated at over 2 million gallons a year. More than one-half of the solid fuel consumed by agriculture and horticulture is used in glasshouse heating, so that the glasshouse industry is shown to be one of the important fuel consumers in this country. Moreover, although nurseries are able to some extent to stock-up during the summer months, much of the demand for fuel comes during the winter months, when other consumers are also making heavy demands on supplies.

The restriction of supplies of solid fuel must inevitably cause growers to turn their attention to other means of glasshouse heating, but lack of foreign exchange with which to purchase oil fuel limits the further conversion of heating systems to oil burning. At one time electrical heating was canvassed as a possible alternative to coal if the price of electricity were in the region of ½d. per unit(2), but it was later shown that a much lower price was essential before a general adoption of electrical heating in glasshouses was likely on economic grounds(3).

All these facts, in the aggregate, mean that efficiency in fuel utilization must be the aim of every consumer and that economy must be sought in the more efficient use of the solid fuel already available. While this is important for national reasons, it is no less important to the individual grower. Fuel is an expensive item, and inefficient use means, in effect, that money goes up the chimney without a corresponding value in heat being obtained.

During the winter of 1947-48 glasshouse growers were restricted in their purchases of fuel to a maximum of 180 tons per acre of heated glass devoted to food crops. In previous years different areas had different methods of allocating fuel to glasshouse growers. The imposition of a maximum tonnage can well have serious consequences for some growers if their consumption rates are determined by factors outside their control. That is to say, the imposition of a standard allowance forces, and quite rightly forces, growers to seek every possible way of achieving efficiency in use but places a handicap upon those growers who, in existing circumstances, work under the disadvantage of an overriding and possibly ineradicable factor which determines fuel consumption rates.

This note is concerned with two aspects of glasshouse heating, namely, (1) the extent and causes of the variation in consumption rates per unit area, and (2) the effect of the imposition of a standard allowance on the possible total quantity consumed and on the fuel supply of different sizes of nurseries.

Fuel Consumption and the Area of Glass

A measure of efficiency in fuel utilization is the inverse of the weight of fuel used per unit area to maintain a given temperature for a given period. It hardly needs stating here that efficiency depends on a number of factors, of which the most obvious are the age and condition of the houses, the age and condition of the boilers, and the

amount of insulation given to exposed parts. All these factors are connected with the capital equipment of the nursery. There are also labour and managerial factors such as the method of stoking, the skill of the stoker, the type of crop grown, and the temperature which is maintained. Much less obvious is another factor—the area of heated glass on an individual grower's nursery.

The technical factors mentioned above are matters which fall into the province of the grower himself and the fuel engineer. Here we are concerned with the effect of the last factor, i.e., the area of heated glass, per nursery, on consumption rates per unit area.

Some light on the position is given in a recent study of conditions in the county of Middlesex([4]). On specialized glasshouse holdings having a total area of 211 acres of glass 21.7 per cent of the nurseries had under ⅛ acre of glass each, 50.2 per cent had between ⅛ acre and 1 acre each, and 28.1 per cent had over 1 acre each. These three groups respectively had 1.1 per cent, 16.3 per cent, and 82.6 per cent of the total area of glass.

The effect which this form of set-up has on fuel consumption is well illustrated by a sample of 91 nurseries in Middlesex for which fuel consumption figures are available prior to rationing. The following table summarizes the relevant information for this sample.

Acreage of Glass per Nursery	Number of Nurseries	Total Acreage of Glass in Group	Average Fuel Consumption *tons per acre*
Under ⅛ acre	15	1.0	308
⅛ to ¼	11	1.9	192
¼ — ½	15	5.6	135
½ — ¾	7	4.3	179
¾ — 1	8	6.5	117
1 — 1½	12	14.2	93
1½ — 2	4	6.6	118
2 — 3	5	12.1	98
3 — 5	8	30.5	121
Over 5 acres	6	52.6	93
	91	135.3	

The 91 nurseries used a total of nearly 15,000 tons of fuel, but it is the variation in amount per acre between the different size classes which is important. Especially is this so between three broad classes: under ⅛ acre, ⅛–¾ acre and over ¾ acre. The table illustrates the fact that consumption per unit area was highest on the nurseries with a small area of glass but that after ¾ acre a further increase in the area per nursery made no significant difference to the rate of fuel consumption per unit area. This is doubtless due to the fact that above a certain size nurseries tend to be built as self-contained blocks of multi-span houses. Thus, for all practical purposes, no unit of heated glass would exceed, say, a 1-acre block.

Single-Span and Multi-Span Houses The actual consumption of fuel used in heating a glasshouse or block of glasshouses is roughly proportional to the total surface area, horizontal and vertical, i.e., the surface area from which heat losses occur. It can readily be seen that as the horizontal area increases, the vertical area forms a smaller and smaller proportion of the total surface area. On mathematical grounds this fact is sufficient to account for the observed differences in the rates of fuel consumption which have been shown to occur.

In practice, however, the tendency, especially on nurseries with a small total area of glass, is for houses to be built as single-span units. Indeed, in the sample of 91 nurseries 32 were built wholly or mainly as single-span

houses, 46 were built wholly or mainly as blocks of multi-span houses, and 13 consisted of mixed types. Those built as single-span houses averaged 0.23 acre of glass per nursery, and those built as blocks 2.68 acres of glass per nursery. The study already mentioned(4) shows that there is a marked concentration of small nurseries in the "single-span house" type and a marked concentration in the middle and upper-size classes of those nurseries built as blocks. To this extent purely theoretical expectations are, therefore, of less value than if growers built their houses in a standardized manner. Thus if all houses were in single-span units it might be expected that fuel consumption would be proportional to horizontal area only, for every increase in horizontal area would carry with it a more or less fixed vertical area (sides and ends). In practice, then, the expectation lies somewhere between these extreme possibilities.

Brought down to terms of money, these facts mean that between 60 and 70 per cent of the glasshouse growers are involved every year in an expenditure of from £40 to £60 each because they are unable to use their fuel with the same degree of efficiency as the larger men. These figures are also a measure of the magnitude of saving which could be effected by the introduction of some new method of heating small areas of glass, and, as such, constitute a challenge to the heating engineer.

A common impression is that the smaller growers are more wasteful of fuel, not because they are small growers but because they are bad stokers. Such a view is untenable if these figures show anything. On an average the smaller growers, under the limitation imposed by their small scale of operations, are probably just as efficient users of fuel as the larger men from the manipulative point of view. Indeed, from the theoretical expectations already discussed and the fact that the small nurseries have the handicap of the "single-span unit" type of construction in addition to their small size, and bearing in mind that the size alone is sufficient to account for the high rates of fuel consumption per acre, the small man is shown to be at least no worse a user of fuel than the larger man, and may even be more efficient.

Fuel Allowance The introduction of a fuel allowance on the basis of a maximum of 180 tons per acre of glass devoted to food crops could well have had a disturbing effect on the economy of some nurseries. For example, before rationing 31 of the 91 nurseries in the sample were using over 180 tons per acre per year, and 60 were using less than that amount. Of those using more than 180 tons per acre, 90.4 per cent were below ¾ acre; of those using less than 180 tons per acre 66.7 per cent were of ¾ acre or over.

Before rationing the 91 nurseries used 14,814 tons of fuel, but the total consumption at 180 tons per acre could reach 24,300 tons—an increase of 9,486 tons over previous consumption. This possible increase has been brought about through the application of a standard tonnage. Moreover, it has occurred at the time when a number of small growers were denied their usual supplies while a number of the larger growers were enabled to acquire more fuel than they themselves previously considered essential for their needs.

It is important to remember that glasshouses were designed when coal and anthracite were available relatively cheaply and when there was little or no incentive to efficient use. Those days have passed for horticulture as for other industries and their passing has raised problems which are surely not impossible of solution.

While it may fall to the economist to point the way, the more difficult task of devising some more efficient means of heating glasshouses on the smaller nurseries must be left to others. A realization of the need, however, is the first step to its fulfilment. Meanwhile, a case seems to be made out for allowing supplies of fuel to the smaller growers at a higher unit-area rate than the medium-sized growers, and to them, in turn, at a higher rate than the larger growers. Such a step would be justified not only on grounds of fairness but also as a measure calculated to achieve that economy of consumption in the industry which cannot but commend itself to all concerned.

References

1. "Fuel and the Future". H.M. Stationery Office, 330.

2. H. V. Taylor. "Alternative Systems of Heating Glasshouses," *Agriculture* (1934), **41**, 632.

3. C. A. Cameron-Brown. "A Critical Study of the Application of Electricity to Agriculture and Horticulture," B.E. & A.I.R.A. (1940), 43.

4. L. G. Bennett. "Efficiency in Glasshouse Heating," University of Reading. Miscellaneous Studies No. 2 (1948).

BRITISH DAIRY CATTLE

Thoughts from The London Dairy Show

John Green

Broadcast in the B.B.C. Third Programme, October 30, 1948

When the populations of the world flowed from the countryside to urban and industrial centres, it seems strange that bulk milk supplies did not follow them immediately. Yet that was not the experience of the Industrial Revolution anywhere, and I think for two reasons. The first was that people moved ahead of their communications. They went to the mines and factories before the roads and railways could provide fast freight services. (Even as late as 1905 British farmers were asking the railways for better ventilated milk vans.) Secondly, the idea of transporting perishable commodities never occurred to them. Man's experiences of food preservation for winter had taught him to rely on grain and rendered fats for energy, and meat and cheese for the luxury of proteins.

Of vegetables and milk, the vitamins and protective foods he knew nothing very definite before the present century. Organized dairying therefore belonged traditionally to the cheese-making districts, where the cows calved in the springtime with the grass. In districts like Cheshire, Somerset, Lancashire, Ayrshire, and the Vale of Glamorgan, the herds of dairy cows were identified with famous cheeses. These cattle were mostly of the middle-horn breeds which produced milk of an intermediate fat content—ideal for cheese-making, if not for the total quantity of liquid milk on the one hand or the cream extract for butter-making on the other. The dairy work of the farm was done largely by the farmer's wife and daughters. The whey was fed back to pigs. Outside these districts until the middle of last century, corn was up, and horn down. The cow on the arable farm was kept for the house, and the village labourer may or may not have been able to fetch his milk from the dairy. Some producer-retailers did good business near the towns, which were not then as remote from green fields as they are today, and to some the Minton tiles, slate benches and porcelain pans of the suburban modern dairy are still a memory.

Out in the countryside proper the British farmer was still in his broadcloth gaiters, and despised both milk and the cow-keeper. The threatened

depression in corn prices in the 'fifties had turned to a renewed expansion in the 'sixties. The Crimean War closed the seas to Russian grain; the gold discoveries of Australia and California raised prices and the Continent and America were each at war while England enjoyed peace. Rents rose and capital was poured into the land, but mostly in erecting great barns for grain and fattening yards for bullocks which today are so often an encumbrance to the landlord. It was only in counties like Cheshire that some landlords foresaw the fall back to grass and sunk their accumulating profits in model dairies. Probably one of the first of these was that of Lord Tollemache at Peckforton. In fact, when the great depression finally started in 1874 the dairy cow was still not thought of to redress the balance of falling prices in corn. The reputation of Bates' cattle had been undermined by fictitious sales and pedigree fancying, and it was to the beef breeds that Britain turned as the clouds of depression gathered.

There was a reason for this. The very competition that Britain faced from virgin prairies served with new railroads created a demand for improved livestock for the range. The Scottish Shorthorns which had been perfected by Amos Cruickshank began to populate the plains of both Americas (and the white-faced Herefords and the black Angus were ready to follow). Only the West Coast Scotsman, on his windswept pastures adjoining the industrial Clyde, had really learnt the art of producing winter milk for the new industrial population. He had learnt to keep what is now called technically a level dairy, and he reaped the benefit of this experience. In the 'eighties he crowded into England, notably ousting the East Anglian yeoman from the heavy clays of Essex. This invasion of the granary of London during the great depression is one of the most spectacular movements of social history. It eventually roused the South to face realities and to face up to the demand of the big cities for milk. John Bull, cheated by pampas and prairie of the roast beef of Old England, was forced at last to recognize the existence of the urban milk shop. The turn of the century saw the establishment of great recorded herds like those of Lord Rothschild at Tring, George Tylor at Cranford, and the Hobbs at Kelmscott. In 1903 John Speir also introduced milk recording to the authorities in Scotland. Black and white Dutch cattle were established amongst the Philistines in Essex!

Dairying Development If Britain was first then in facing the impact of industrial life on agriculture, how have subsequent changes affected the rest of the world? Let us take the case of three of the newest and largest centres of population. In 1860 the populations of Chicago, Sydney and Buenos Aires were some 109,000, 97,000 and 180,000 respectively. Today those same three cities have populations of approximately 3½ million, 1½ million, and 2½ million. It is little wonder, therefore, that in the case of Chicago and its neighbouring cities a dense population of dairy cows is to be found in the states which surround the Great Lakes, with leading centres of dairy research at Madison and Minnesota. In the case of Sydney, which is immediately surrounded by rock and scrub, liquid milk is now drawn from 300 miles away, in the Northern river districts of New South Wales. Even in the Argentine dairy cattle are slowly supplanting the beef breeds in relative national importance. This great demand for milk for town supply and the improvement in techniques in handling it are therefore universal. Bulk carriage in glass-lined containers has overcome the noise and tedium of rolling churns. Pasteurization has made milk safe after long journeys. Electricity has brought hot water and refrigeration to the remotest farm. Veterinary science has enabled the herds to be kept

reasonably free of tuberculosis and other diseases. Artificial insemination has extended the influence of the proven sire and none of these advantages yet marks the final milk milestone.

Now Britain has not been backward at any stage in the development of dairy technology. The clean milk campaign owes much to the work of the National Institute for Research in Dairying at Reading. The Ministry's Laboratories at Weybridge have also made their contribution to animal health. (Even more is expected of the ambitious experiments of the Agricultural Research Council, at Compton in Berkshire.) The Hannah Research Institute in Ayrshire has always sought to keep abreast of the latest knowledge concerning the nutrition and physiology of the dairy cow. In London, the Society of Dairy Technology, which was founded during the war, has today a membership of 1,200, comprising representatives of the distributing trade, the dairy equipment industry with the advisers of the milk producers. The Milk Marketing Board, inaugurated under Mr. Walter Elliot's Marketing Acts in 1933, may be regarded as a model of efficiency in producer-marketing. Before the war it had to stimulate the consumption of milk by promoting trade in milk bars and ice cream, whereas today it has to set up new and ambitious targets for farmers in order to satisfy the increased demand of the British public for liquid milk. This year the sale of milk from British farms amounted to 1,320 million gallons, or 200 million gallons more than in 1939, and over 50 per cent more than during the first year of the Board's existence—fourteen years ago. Much of this increased consumption is due to the Government's milk in schools and nursing mothers' scheme, which is a piece of social service of an enlightened kind and probably the only food subsidy about which no party would quarrel. It had a great influence on maintaining efficient standards during the war years and subsequently.

Now to meet these expanding opportunities, what has Britain to offer in the way of dairy cattle ? Will British dairy breeds ever rival in fame the great beef and mutton breeds that have gone out from this small island to stock the grazings of the world ? They have had a bad start. England has no pure dairy breed to its credit. The Dairy Shorthorn, our most numerous breed, still aspires to the dual-purpose standard which is justified in a country that must look for meat from its dairy herd, but is not so attractive where cheap stores can still be reared on range. Of the four avowedly single-purpose dairy breeds, one is Scotch, one Dutch, and two Channel Islands. The question that arises is—will British soil and climate and our innate stock sense be able to create from these exotic origins supreme types of dairy cattle ? There is already visual evidence that this is happening. The former heavy-boned Netherland cattle are showing better type and conformation in this country, and the lighter and sometimes shelly Channel Island types have filled out in stature. Records of performance, too, show annual improvements. The best British dairy herds already hold their own with the dairy cattle of other countries. For example, our national herd averages for some 14,000 recorded herds of all breeds is now over 700 gallons per cow. In an individual case, a herd of British Friesians averaged over 1,700 gallons, and such records are not often surpassed in other parts of the world.

A darker side of the picture is the performance of our average dairy cows. These still comprise some 85 per cent of the national dairy herd, and two-thirds of them are composed of units of fifteen cows or less (of which nearly half have only begun to sell liquid milk during the last ten years). Their average yield is computed to be between 500 and 550 gallons, as against Denmark and the Netherlands, the premier dairying countries of Western Europe, where the national herd yields are 700 and 770 gallons

respectively. The question is, therefore, whether the British national herd average can be raised to that of our European competitors and of our recorded herds, because that, more than the continued improvement of our own best herds, would justify the faith of the outside world in British dairy stock. It would show that Britain was serious about breeding for milk.

It is true that the war brought many problems to our dairy farmers: and that despite this, the national dairy herd has increased in numbers. Also, that before the war, large quantities of concentrates—maize, oilseeds and nuts—were imported every year, notably from South America and India. In 1946 the quantity imported was less than a quarter of the pre-war amount, and whereas in 1938–39 it was estimated that we were feeding 23 cwt. to each cow, at the end of the war the quantity was only 16 cwt. Also, pre-war only 4.3 of the total quantity of concentrates were home grown, whereas today 42 per cent, or nearly half, is produced off the British farm. An even more significant change has been the shifting emphasis of efficient milk production from the traditional dairying districts in the English plain to the eastern arable counties. The records of most breeds tend to show better returns from the east of Britain, for the obvious reason that more home-grown food can be produced on a large arable farm than on the small dairy farm, which has to rely on the seaports of the Bristol Channel, the Mersey, or the Clyde, to make up its acreage deficiencies.

British Dairy Cattle and the Export Market

So we come to the sixty-second annual Dairy Show that has just closed at Olympia, and which was honoured for the first time by a visit from the King and Queen. Entrants, which were nearly double those of last year, competed for £6,000 in prize money and brought very strong competition from all breeds. The individual champion cow—a seven-year-old British Friesian—averaged during the week an equivalent of 10 gallons of milk a day and 4 per cent butter fat. (Looking back in the records of milking cows, we will find that it was only in the 'twenties that the 6-gallon cow was beginning to appear normal, while the 8-gallon cow was regarded as a phenomenon of the 'thirties.) The reserve champion was an Ayrshire, which stood top on inspection, and had given 8 gallons of milk at 4.6 butter fat. The much coveted inter-breed competition for the Bledisloe Cup was also a victory this year for the British Friesian. They had a very clear lead as a result of their performance in the milking trials, although eventually they only beat the Ayrshires by a margin of 13 points. Ayrshire cattle nowadays show a perfection on appearance, which is all the more creditable since they have had to overcome that period of conceit in their history when their udders became so refined that it almost came to a question of milking them with the thumb and forefinger. That would never have suited the present age of the milking-machine. And the Friesian, too, let it be remembered, was catalogued at the Dairy Show forty years ago merely as Dutch, and its butter fats were often below today's statutory requirements. Such are the obstacles that the live-stock breeder must overcome and which accounts for the hard-held supremacies both of breed and individual breeders Today we must surely all acknowledge the achievements of the British Friesian and Ayrshire breeders, whose harvest at Olympia is much the result of intense industry and application.

Once again, then, can we convince the rest of the world of the strides which the dairy industry is making in Britain? As against Holland, Denmark and the Channel Islands, or the United States of America, can

people in the rapidly expanding southern hemisphere be persuaded to regard Great Britain as a dairying country ? A recent statement was issued to the effect that Great Britain had exported, in the last three quarters, more than £3,000,000 worth of pedigree stock. Dairy cattle figured prominently amongst these shipments. However, I am certain that to the average Australian, Argentinian, South African or New Zealander, the statement merely conveys an impression of thoroughbred horses, beef cattle, and sheep. It is perhaps moral justice that fame should die as slowly as reputation is acquired.

I have referred to the increasing demand of the world's population for liquid milk so that obviously volume yields and the appearance of milk in the bottle on the doorstep are great considerations. The only warning I would make is that we do not become too concentrated on our own immediate home market requirements. Most of the world's milk still goes to creameries. Total butter fat during the lactation is as important as butterfat percentage. Moreover, the cost of milk and butter per acre is quite as important as the individual performance of cows. The Buckhurst Challenge Cup, presented for the first time by this year's President of the Show, Lord De La Warr, took into consideration such factors as consistent breeding, milk yield over a period of years, the butterfat content and the live weight of the animal. It is significant that only three animals entered for the competition. The milking life of a cow is obviously a vital factor in relation to the cost of milk. Finally, there are other things to think about. Should a dual-purpose animal be beef in itself or one that is capable of being crossed for beef ?—because this consideration of size and scope might bring the British Friesian into the dual-purpose category. And there is also a warning for some breeds like the Red Poll, which are not wanted for dairying everywhere overseas, that too much milk in a cow that has to suckle its own calf may be an objectionable feature. When all these points have been considered, let us remember that a Saanen goat during the week gave its own weight in milk. By that comparison, most dairy cows are very inefficient milk producers.

AGRICULTURAL INDEX NUMBER

Monthly Index Numbers of Prices of Agricultural Products Including Government Grants. (Base 1927–29 = 100)

Month	Uncorrected for Seasonal Variation					*Corrected for Seasonal Variation*				
	1939	1945	1946	1947	1948	*1939*	*1945*	*1946*	*1947*	*1948*
January ..	95	192	199	217†	†241	*89*	*173*	*179*	*193†*	*†215*
February	94	193	201	211†	†240	*88*	*176*	*182*	*190†*	*†217*
March ..	91	185	192	201†	†232	*91*	*178*	*183*	*191†*	*†220*
April ..	90	167	176	186†	†214	*95*	*173*	*182*	*192†*	*†222*
May ..	82	154	162	171†	†198	*91*	*173*	*181*	*192†*	*†223*
June ..	80	154	161	170†	†197	*89*	*174*	*181*	*193†*	*†225*
July ..	85	162	168†	181†	†198	*93*	*177*	*182†*	*197†*	*†216*
August ..	86	162	176†	192†	†211	*91*	*174*	*191†*	*208†*	*†228*
September	92	159	177†	206†	†210	*93*	*166*	*188†*	*222†*	*†227*
October ..	96	179	192†	221†		*92*	*172*	*187†*	*215†*	
November	106	191	209†	235†		*98*	*177*	*192†*	*217†*	
December	113	197	214†	241†		*103*	*178*	*192†*	*216†*	

† Provisional.

THE TOWN AND COUNTRY PLANNING ACT AND THE FARMER

KENNETH KING, B.A.

To most countrymen the theory and practice of Town and Country Planning may have seemed remote from the immediate realities of their everyday life and work, and of small importance to agricultural development. Some, however, because of their nearness to built-up areas, are more aware of the dangers which absence of careful planning may incur. Farmers, accustomed to the discipline of planned working, would willingly accept some further restraint on individual choice if by so doing agriculture's claim for the right use of the country's land would be generally acknowledged.

It was not until the middle years of the last war that by the establishment of the Ministry of Agriculture's Rural Land Utilization Organization the agricultural interest was put on a level in national, regional and local deliberations with other claimants for the use of land. Experience of the Town and Country Planning Act of 1932 disappointed those who had hoped that its provisions would benefit agriculture and the countryside. Indeed its working, in at least one respect, was inimical to those interests, for its mechanism, and the dread of compensation which it instilled, resulted in the production of rigid schemes of "zoning" large areas of agricultural land. These were thus held under apparently perpetual threat of development, and there was, in fact, little protection against urban infiltration.

In 1943 a system of development control was devised to be nation-wide, and a new code of post-war planning was foreshadowed. The Town and Country Planning Bill was introduced in January, 1947, and the Appointed Day for the coming into operation of the Act was July 1, 1948. Critical debate at all Parliamentary stages, much publicity in the press, and country-wide discussion have apprised us of its principal provisions, although we have as yet little experience of its working. Its reception popularly and professionally has been a mingling of hostility, irritated perplexity, and apathy, with some partisan enthusiasm for it as a handful of nails in the landlord's coffin. This reaction does less than justice to the intentions of which this bulky and intricate enactment is the expression. Whatever his politics the farmer who realizes the importance of the Town and Country Planning Act to the agricultural industry and the countryside, will wish to have a clear and well-informed understanding of it. He may discover that at the cost of some small concessions to systematic planning he is assured for his land and his business the protection which hitherto he has not enjoyed, and that many of the hazards to which a life's work was previously exposed (for example, the sale of his land for building or quarrying, or the movement on to it or near it of agriculturally harmful or competitive activities) are being, if not wholly eliminated, brought under surveillance and control.

THE Town and Country Planning Act is, to quote the Preamble: "An Act to make fresh provision for planning the development and use of land, for the grant of permission to develop land and for other powers of control over the use of land; to confer on public authorities additional powers in respect of the acquisition and development of land for planning and other purposes, and to amend the law relating to compensation in respect of the compulsory acquisition of land; to provide for payments out of central funds in respect of depreciation occasioned by planning restrictions; to secure the recovery for the benefit of the community of development charges in respect of certain new development; to provide for the payment of grants out of central funds in respect of expenses of local authorities in connection with the matters aforesaid; and for purposes connected with the matters aforesaid."

It will be found that the Act has six objects, separate although related. These are:

FIRST: To institute a new system of planning control by a greatly reduced number of planning authorities, each responsible for the preparation of a flexible development plan which is to be subject to constant review and five-yearly confirmation, revision and extension. This system replaces that prescribed by the Acts of 1932 and 1943: the rigid operative planning scheme and interim development control by, in the main, the vast number of County District Councils.

By the limitation of planning control powers to County Councils and County Borough Councils, the number of local planning authorities is reduced almost exactly ten times; from 1441 to 145.

SECOND: To prohibit, with specified exceptions, the carrying out of any kind of development, unless and until the consent of the local planning authority has been obtained.

THIRD: To provide with specified exceptions for the levying by the Central Land Board of development charges to be paid or secured to the Central Land Board before any kind of development is begun.

FOURTH: To expropriate for the State the development value of all land and to provide for payments to be made, on grounds of hardship, to owners of land in respect of depreciation in the value of their land resulting from the loss of development value.

FIFTH: To widen the powers of local authorities to undertake development for themselves and to acquire land compulsorily; and to increase the financial assistance to local authorities to enable them to discharge these and other functions under the Act.

SIXTH: To amend the law relating to compensation for compulsory acquisition of land by abolishing the 1939 standard of values.

Not all of these objects are of equal importance to the farmer. On the first the relevant comment is that the flexibility of the five-yearly reviewed development plan is, in the rural interest, greatly preferable to the rigidity of the now outmoded operative planning scheme, that inevitably unsuccessful attempt to cover the map with use zones, density zones and "G.D.O." areas and to provide forever for every possibility of urban expansion. The fifth and sixth objects are mainly of an administrative and financial character; the provisions are intricate and certain of the principles contentious. Attention should be called to the wide range of developments and redevelopments which local authorities are now empowered, and may well need, to undertake: and in particular to the new provision whereby in a development plan agricultural land may be designated as subject to compulsory acquisition within a period of seven years.

Of the six objects there remain for consideration three; the second, third and fourth in the catalogue. These are certainly of outstanding importance. Briefly to recapitulate: No development may take place without the permission of the local planning authority. No development may take place until the Development Charge has been determined by and paid to the Central Land Board. The development value of land has passed to the State and for the loss of that development value the owner may claim compensation from the State.

Planning Permission The layman's answer to the question: "What is development of land within the meaning of the Act ? " is, "Everything (except to go on farming it) that you could possibly want to do with it, on it, over it and under it, including changing the use of it". The use of land for agriculture or the change from one kind of farming to another (e.g., stock farming to fruit farming) is not development, but building work, whether for dwellings or farm buildings, is development. It would indeed cause trouble and vexation to the owner and manager of land, and, incidentally, to the planning authority, if for every act and operation on, over and under it, and for every change of use permission had to be sought, and there are, in the Act, some minor exceptions to the rule and in the Regulations some very important exceptions to it which require and will abundantly repay careful study. The farmer will discover that the agricultural industry benefits substantially by many mitigations, dispensations and easements.

A list of some of the developments, operations and changes of use which do not require planning permission is interesting:

Internal or external improvements, alterations or maintenance works which do not materially affect the external appearance of any building.

The erection or construction on land used for the purpose of agriculture of:

1. Any buildings, except for human habitation, not permanently affixed to the ground.
2. Separate buildings, except for human habitation, permanently affixed to the ground not exceeding 300 sq. feet superficial area and 13 feet in height, and not more than 150 feet from the group of principal farm buildings.
3. Silos not exceeding 14 feet in height.
4. Wells and reservoirs or tanks not exceeding 14 feet in height nor 20,000 gallons in capacity.
5. Straw pulping plants, hop-pole tarring plants, sheep dips and lambing pens.
6. Structures mainly or wholly of poles, straw, bracken, hurdles or like materials.

The formation, alteration and maintenance of private ways.

The erection, improvement or alteration, except on trunk or classified roads of roadside stands for milk churns.

The winning and working on land held or occupied with land used for the purposes of agriculture of any minerals required for the purposes of that use, and the alterations of buildings or works thereon which are occupied or used for the purposes aforesaid.

The carrying out of any works for the inspection, repair or renewal of sewers, mains, pipes, cables, or other apparatus, including the breaking open of any road.

The erection or construction of gates, fences or walls not exceeding 7 feet in height and not abutting on a highway.

The use of land unoccupied by buildings for any purpose for periods not exceeding 28 days in one year, and the erection or placing of moveable structures for the purposes of that use, e.g., fairs, shows, occasional camping sites.

The use of land unoccupied by buildings and not within the curtilage of a dwelling house for recreation or instruction by members of certain recreational organizations.

The foregoing list of developments and changes of use for which permission need not be obtained from the planning authority is not complete. It selects certain of the rural and agricultural items from a lengthy and detailed catalogue of the permitted developments; and in paraphrase and by compression some legal quiddities and qualifications have been lost. The objective has been to summarize, avoiding gross inaccuracy on the one hand and extensive repetition of the phraseology of the Act and the Regulation on the other, those exemptions which the farmer wishes and needs promptly to recognize in the day-to-day conduct of his business. For the elucidation of the nicer points and more complex problems he must rely upon careful scrutiny of the Act and the Regulations, or upon advice from his solicitor—preferably both.

Broadly, it is true to say that the maintenance and minor improvement of country property will not be delayed or curtailed by the formalities of planning control. Broadly, again, it is true to say that it is the major improvement, the substantial alteration and the obvious innovation which require the permission of the planning authority.

So much for the consideration of whether or not permission to develop is necessary. What about liability for the payment of development charge? Here must be mentioned a very real and present danger of confusion. We have noted that there are some operations and changes of use which in the meaning of the Act are not development. These do not require planning

permission; neither are they liable to development charge. But there are other operations and changes of use which *do* require planning permission but are *not* liable to development charge. It does not necessarily follow, therefore, that because planning permission is required liability to development charge is incurred. And similarly it does not follow that because an operation or change of use is exempt from development charge planning permission for it need not be obtained.

A simple example will illustrate the danger of confusion. The reader of the General Development Order finds in the "First Schedule. Permitted Development. Class VI" the following:

"The erection or construction on land used for the purposes of agriculture of:

> (1) separate buildings for such purposes permanently affixed to the ground and having a superficial area of not more than 300 sq. feet and a maximum height (measured to the ridge thereof, if any) of 13 feet, being not more than 150 feet from the group of principal farm buildings occupied with such land and not for human habitation."

He might jump to the conclusion that there would be liability for development charge on any building exceeding the specified limits of size and distance. He would be wrong; but safely wrong.

Similarly the reader of the Central Land Board's Form D.I.A. finds in the "Summary of Common Cases in which no Development Charge is Payable" the following:

> "The carrying out on land used for any agricultural purpose of any building or other operations (other than the erection, enlargement, improvement or alteration of dwelling houses) requisite to the farming of the land for that purpose."

He might assume that planning permission for this development was not required. He too would be wrong; but dangerously wrong. And who would be right? The reader of both, who, comparing carefully one exemption with the other, knows that he can do some things without planning permission and without liability for development charge, but that for many of the things which he might do without liability for development charge he still requires planning permission. The importance of this distinction to the understanding of the Act cannot be over-emphasized.

Development Charge What is development charge? It is the amount to be paid to the State in respect of the increase in the value of the land which results from permission to develop it. This amount is assessed and collected by the Central Land Board and it must be paid to the Board or security for it given to the Board before the development is begun.

Again, it would cause trouble and vexation to the owner and manager of land, and incidentally to the Central Land Board, if in respect of every development a charge had to be determined and paid, and there are in the Act and the Regulations some very important exceptions to this rule. Again, these exceptions require and repay careful examination, and it will be found that the agricultural industry benefits substantially by them. The following are some of the developments which are excepted from liability to charge:

> The rebuilding as often as required of any building so as not to exceed by one-tenth (or 1,750 cu. feet in the case of a dwelling house) the cubic capacity of the old building.
>
> The use as two or more separate dwellings of any building which was used as a single dwelling house.
>
> The carrying out on land used for agriculture of building or other operations for agricultural purposes, excluding dwelling houses.
>
> The erection or alteration of gates, fences and walls.
>
> The maintenance of private roads.

The temporary use of land for any purpose for not more than 28 days and the erection and placing of moveable structures for that purpose.

The mining and working in land held or occupied with land used for agriculture of minerals reasonably required for that use.

In addition to the foregoing there has been promised a concession of particular interest and value to the owners of agricultural property. It is intended that new dwelling houses or enlarged and improved dwelling houses shall be free of development charge as long as they are reserved for members of the agricultural population, but that if they are used for other purposes, e.g., as weekend cottages, charge shall become payable.

It is hardly necessary to add to these comments on development charge that formal application to the Central Land Board for the determination of it in respect of operations on and changes of use of rural land may result in a Nil valuation. The currently common error of assuming that any development anywhere will unfailingly incur a monstrous fine should be avoided. In fact, the determination of the charge is governed by well-defined principles and is to be calculated by the accepted processes of valuation. For typically rural property Nil valuations or light charges may be agreeably frequent.

We find, then, of development charges, as of planning permission, that by the Act and in the Regulations the agricultural property, the farm and the estate are not overwhelmingly oppressed by restrictions and formalities. It may be useful to remember that when the operations or changes of use are discovered not to require planning permission they are also excepted from development charge. The converse is NOT true. The starting line of any examination is the question: "Is what I want to do development? If so, do I need planning permission?" We may safely work on the assumption that *NO need for planning permission* equals *NO liability for development charge.* But it should be repeated, emphatically, that this is not true the other way round. Excepted development for development charge often requires planning permission.

Claims for Depreciation of Land Value

The Central Land Board has issued an explanatory pamphlet (Form S.I.A.) which can be obtained free of charge from the office of any County District Council, where also claim forms are stocked

The explanatory pamphlet is clear and helpful. It should be read by every owner of land, and many may find that with its guidance the formidably lengthy claim form can be understood and completed without undue difficulty. Provision is, however, made for contribution by the Central Land Board to costs incurred by claimants for professional assistance in the submission of claims. Claims must be made before March 31, 1949.

It is said that some owners hesitate to claim for the depreciation of land value lest by so doing they should encourage the planning authority to "zone" the land for development. There is surely some misunderstanding here. The planning authority is most unlikely to be influenced in its judgment as to the suitability of land for development of one kind or another by the owner's exercise of his right to claim. The planning authority may not even know by whom claims have been made, for what amounts and in respect of what areas. The prudent advice which one would offer to any owner is to submit, where he considers himself so entitled, his claim or claims, disregarding the intentions, guessed at or feared, of the planning authority.

The treatment of "dead ripe" and "near ripe" land and of mineral-bearing land is of special interest to the owners, but it lies outside the scope of this paper, and should be the subject of careful consultation with

specialist advisers. No further comment on this subject is necessary except perhaps to remind the farmer that claims at less than the rate of £20 per acre are not admissible.

The Tenant Farmer Normally, the tenant farmer, unless he himself is undertaking a development under the terms of his tenancy, or with the landlord's consent, or with the Minister of Agriculture's approval under the Agriculture Act, will not be concerned at first hand in application for planning permission or the determination of development charge: nor would a tenant farmer claim under the terms of the Planning Act for the depreciation of land value, for that is the business of the owner. Nevertheless a tenant might himself wish to erect for farming purposes a temporary building of such size and in such a position as to require planning permission, in which circumstances he might reasonably be asked by the landlord to undertake the formalities. In the event of non-compliance with the law, it would be the person who undertook the development, and not necessarily the owner of the land, who would be held accountable. The tenant farmer should in his own interests, therefore, not merely refresh his memory as to what he may or may not do under the terms of his tenancy and agricultural law but ensure that he does not unwittingly contravene planning law; and in all instances, unless he is satisfied that the development is permitted and exempt from development charge, he would do well to agree with the landowner or his agent by whom action is to be taken to comply with the provisions of the Act.

Procedure A final note on the procedure for obtaining planning permission and the determination of development charge may be of practical value. The applicant should obtain from the offices of his County District Council a set of the printed forms which have been prepared for this purpose. He will find that instructions for completing them and the requirements of the planning authority in respect of drawings and plans are clearly set forth. The appropriate officer of the Council will be willing to elucidate any difficulties or uncertainties of procedure, but he should not be expected to act as professional adviser. The applicant may find that for certain classes of farm buildings the planning authority will not trouble him for detailed drawings, so that for, say, a chitting house of glass and steel, requirements will be satisfied by verbal description, a note of the dimensions, and a site plan. The forms, completed and accompanied by the drawings and plans, are lodged with the County District Council, whose responsibility it is to distribute the copies to the planning authority, and where appropriate, the Central Land Board. In certain counties administrative machinery has been created for the specially prompt treatment of straightforward applications, and everywhere the planning authorities have instructions to expedite the business to the utmost. The farmer will be interested in and appreciate the provision whereby permission for a farm building cannot be refused without consultation between the planning authority and the County Agricultural Executive Committee. In due course, the applicant is informed of building bye-law and planning decisions, and of the Central Land Board's determination of charge. The reasons for disapproval or the imposition of conditions will be stated, and if aggrieved by the decision the applicant has the right to appeal.

It is in his own interests that at the outset the applicant should be at pains to define his proposals accurately and fully, and to comply with the requirements of the planning authority and Central Land Board as to information, plans and drawings. Some delay in the settlement of important or difficult applications may be inevitable, but experience reveals that much

time can be lost unnecessarily by the applicant's failure to provide at the outset the material for which he is asked. In conclusion it should be remembered that in this, as in other aspects of planning negotiations, the persons and authorities responsible for administration are not yet so fully versed in the science, technique and jargon of farming as to understand as promptly and clearly as could be desired the farmer's requirements and objectives. Lucidity and exact description and definition will frequently be repaid.

RURAL MARKET

THERE are few human activities, habits and preferences which have not in the past few years come under the probe of the inquiring sociologist. The method is to take a representative cross-section of the public, and from the part to assess the whole. The accuracy of the findings based on this sampling method has been called in question on more than one occasion, but, generally speaking, it is admitted that the results so economically obtained provide a fair picture and a useful guide to those whose interests, commercial and otherwise, are likely to be affected by the trend of collective opinion or changing fashion. The efficient business man's first concern is his market, and even a high degree of consumer research is justified on the grounds of avoiding the wastage of time, money and labour in a field where the demand for a particular class of goods no longer exists. The axiom "know your market" is sound, fundamental economics.

*Rural Market** is the latest *aide* in this sphere of consumer inquiry, and should prove useful to urban manufacturers, especially, and of no small introspective interest to the farming community and rural folk generally. Here, as the result of four independent investigations during 1947, is presented an array of statistical data dealing with the agricultural pattern of Great Britain, how the farmer buys his supplies and equipment, the domestic and social activities of the rural housewife, and some diverse facts about the rural population generally. The coordinating outline of British agriculture which is included is eminently readable. After nearly two hundred years of industrialization, 81 per cent of Britain's 56.2 million acres is still devoted to agriculture in one form or another, and 5.6 per cent is covered by forests. The value of the United Kingdom agricultural output (for 1945-46) is shown as £608,304,000 sterling, a figure far in excess of those for Canada, Australia, Holland, or Denmark.

With the rural housing problem still very much in our minds, it is of interest to compare the total number of cottages, county by county. Kent has the highest (12,960) and the Soke of Peterborough the lowest (280), out of a total for England of 190,340, giving an overall figure for the country of 56 cottages per hundred regular adult male workers.

Elsewhere in the survey it appears that many farmers do not specify the brand of fertilizers, dairy concentrates and tractor tyres that they buy; they leave the choice to their dealer. But they are much more selective when it comes to tractor lubricating oil. On the distaff side, most agricultural housewives buy their provisions and such things as polishes and cleansers in the village, but go into the market town or nearest large city for their hardware, clothing, and bed linen.

But the survey provides much more than the facts to which the figures specifically relate. Much can be read into them; to the social and economic historian they will be signposts on the road of rural development.

S.R.O'H.

* Published by Hulton Research, Hulton Press, Ltd. 21s.

CERTIFICATION MARKS FOR THE POULTRY STOCK IMPROVEMENT PLAN

R. Coles, M.Sc. (Econ), M.Sc. (Agric.), B.A., Ph.D.

Chief Poultry Advisory Officer of the Ministry of Agriculture and Fisheries

It is a common cry that branded goods are best. This is a reasonable opinion because it implies the producer's confidence in his own goods. It follows, therefore, that the use of a particular brand or trade mark must be confined to a particular firm or trade organization, and for that reason trade marks are registered. They cannot then be used legally by any other body.

One of the difficulties connected with the old Accredited Poultry Breeding Stations Scheme was the abuse to which the term "Accredited" was exposed. Such a word could be registered only if incorporated in an original design. The rise of Accreditation and the increased confidence in stock produced by Accredited Breeders led not infrequently to stock being described as "Accredited," when, in point of fact, suppliers were not breeders in the Accredited Poultry Breeding Stations Scheme. The Ministry has therefore applied for registration of the certification marks associated with the Poultry Stock Improvement Plan, so that their use can be confined strictly to stock suppliers who are full members of the P.S.I.P.

Registration of the designs here shown is now being sought. Later, when the Approved Section of the Plan is in operation, there will be an additional mark for Approved Hatcheries. Registration is being sought for the marks in all colours so that stock suppliers having the right to use them will be able to reproduce them in any colour on their stationery, advertisements, etc. The official colours—if one may use such a description—will, however, be blue for Foundation Stock, red for Breeders' Grade, green for Commercial Stock Suppliers, and purple for Accredited Hatcheries.

In accordance with the usual procedure relating to the use of such marks, it is contemplated that members of the Poultry Stock Improvement Plan will have to make application to the Ministry of Agriculture for permission to use them. This permission will be granted only to fully Accredited suppliers, who will then be entitled to show on their stationery the marks for those grades in which they have been accepted in the Plan.

It is hoped that the use of these Certification Marks—when registration is fully completed—will be of value to both breeders and hatcheries in the Plan and to buyers. The use of the marks should make the Plan more widely known, and finally, intending purchasers of good quality stock will be able to buy from suppliers showing these marks with the confidence that they are obtaining some of the best poultry stock in the country.

THE MINISTRY'S PUBLICATIONS

Since the date of the list published in the September, 1948, issue of *Agriculture* (p. 273), the undermentioned publications have been issued.

Bulletins Copies are obtainable at the prices mentioned from the Sales Offices of H.M. Stationery Office or through any bookseller.

No. 55 Outdoor Salad Crops (*Revised*) 1s. (1s. 2d. by post).
No. 119 Plums and Cherries (*Revised*) 2s. 6d. (2s. 8d. by post).
No. 140 Wild Birds and the Land (*New*) 2s. 6d. (2s. 9d. by post).

Advisory and Animal Health Leaflets Single copies of not more than 16 leaflets (four in any one group) may be obtained, free of charge, on application to the Ministry, 1-3 St. Andrew's Place, Regent's Park, London, N.W.1. Copies beyond this limit must be purchased from the Sales Offices of H.M. Stationery Office, price 1d. each net (2d. by post), or 9d. net per doz. (11d. by post).

Group III. Pests and Diseases of Fruit Crops

(a) INSECTS AND OTHER PESTS.
No. 30 Gooseberry Sawfly (*Revised*).

Group IV. Birds

No. 244 The Rook (*Revised*).

Group V. Other Subjects

No. 328 The Importance of Bees in Orchards (*New*).
No. 330 Acarine Disease of Bees (*New*).
No. 332 Spraying Programme for Apples and Pears (*New*).
No. 333 Orchard Renovation (*New*).
No. 335 Rootstocks for Apples and Pears (*New*).

Animal Health Leaflets

No. 3 Braxy (*Revised* — superseding Advisory Leaflet No. 331).
No. 5 Fowl Pox (*Revised*—superseding Advisory Leaflet No. 145).
No. 7 The Sheep Nostril Fly (*Revised*—superseding Advisory Leaflet No. 14).
No. 9 Swayback in Lambs (*Revised*—superseding Advisory Leaflet No. 301).
No. 10 White Scour in Calves (*Revised*—superseding Advisory Leaflet No. 21).
No. 11 Foot Rot in Sheep (*Revised*—superseding Advisory Leaflet No. 95).
No. 12 Blackhead of Turkeys (*Revised*—superseding Advisory Leaflet No. 298).
No. 13 Salmonella Infection of Poultry (*Revised*—superseding Advisory Leaflet No. 298).
No. 14 "Husk" or "Hoose" in Calves (*Revised*—superseding Advisory Leaflet No. 15).
No. 15 Colds and Contagious Catarrh in Poultry (*Revised*—superseding Advisory Leaflet No. 327).
No. 17 Mastitis in Cattle (*Revised*—superseding Advisory Leaflet No. 295).

Marketing Leaflets

No. 101 Recommended Grades for Apples produced in England and Wales (*New*) 2d. (3d. by post).

Other Publications

British Agricultural Mission to South America (Agriculture Overseas Report No. 8) 1s. (1s. 2d. by post).
Farmers' Income Tax (*Revised*) 6*d*. (7*d*. by post).

BOOK REVIEWS

The Geography of the Flowering Plants. Ronald Good. Longmans Green. 30s.

This elegant production can be regarded as good background reading for the technical officer or crop producer interested in something beyond the mere agronomy of the very small number of plants which, in proportion to the total world flora, are of economic value in this and other countries. Much of the work fundamental to the introduction of new economic plants or to the dispatch of collecting expeditions to regions likely to contain suitable types requires to be based on a thorough knowledge of the facts of plant geography, the world's natural regions, the capacity of genera and species to become adapted to new environments, the homoclimal basis of comparison of habitats, and so on.

Since the book is intended primarily for the university botanist, it is natural that the greater part of it should consist of a detailed discussion of the distribution of plant families, genera and species, which is rather too specialized for the general reader. The other chapters in Part I are, however, of greater concern to the British reader who is interested in the history and distribution of the British flora, and in a special study of plant distribution in an English county. The county selected for study is Dorset, which although small, is remarkably varied in its topography and geology, and affords an almost unrivalled series of plant habitats ; maps in this section show the distribution of *Primula vulgaris*, *Clematis vitalba*, *Molinia caerulea* and *Picris echioides*.

Part II contains in eight chapters a full review of the natural factors which govern the distribution of plants ; these are classified as climatic factors, soil factors, factors concerned in dispersal, changes of climate, and geographical changes. The two primary climatic variables are stated to be temperature and moisture ; the secondary ones are light and wind, so regarded because they exert their influence by modifying the two primary variables of temperature and precipitation. The edaphic factors are seen as comprising three components, namely, the physical nature of the soil, the chemical nature of the soil, and the topographic or physiographic character of the habitat.

The author proceeds from this to a presentation of his own theory of tolerance evolved to provide the missing links in the theory of climatic migrations, now thought to be inadequate. The first few sentences of the theory of tolerance are :

" Each and every plant species is able to exist and reproduce successfully only within a definite range of climatic and edaphic conditions. This range represents the tolerance of the species to external conditions. The tolerance of a species is a specific character subject to the laws and processes of organic evolution in the same way as its morphological characters, but the two are not necessarily linked. Change in tolerance may or may not be accompanied by morphological change, and morphological change may or may not be accompanied by change in tolerance."

This naturally leads to a brief consideration of the current research of the physiologists on growth, development and reproduction in plants, and the factors which govern growth and mere existence, and reproduction respectively.

R. O. W.

The Story of Plants. John Hutchinson and Ronald Melville. Gawthorn. 40s.

The child in school is taught—if he is lucky—to identify the commoner wild flowers he finds in the lanes and fields near his home. One child in a thousand may develop an abiding interest from those early lessons and become a botanist in later years, and such children as become farmers or farm workers will of necessity learn something of the habits, needs and cultivation of farm crops and will know as much as needs to be known of the control of " weeds," but no coherent picture of the plant life of the world as a whole, in its parallel evolution alongside man's own, is likely to be gathered from casual study.

The Story of Plants provides that picture, tracing plant evolution from the first days of vegetable life on the earth up to the present time. The first chapter deals with those very early days, but from the second chapter onwards the emphasis is on the interrelationship of plants and animals, with special reference to man. The first steps in cultivation of food crops are indicated, and subsequent chapters deal with grain crops, vegetable culture, wines and other plant beverages, medicines extracted from plants, fabrics woven from vegetable fibres, houses, tools, furniture and utensils made from plant materials. The last chapter, looking ahead, is full of provocative suggestions as to lines of development—fruits without fertilization, growth hormones, motor fuels from wood, fabrics from seaweeds, and so on.

As well as being a mine of information attractively presented, the book is profusely illustrated in colour by Flora Kendrick, with pictures of old favourties from our own fields side by side with pictures of exotic tropical species and three fine charts showing the family tree of the main groups of plants.

I suppose the book is intended primarily for young people, but I suggest it should be placed in all general county libraries as well as in those supplying only to schools.

E. M. B.

BOOK REVIEWS

The Countryman Book. Compiled by J. W. Robertson Scott. Odhams. 10s. 6d.

There is no doubt that this book, coming so opportunely for Christmas, will find its way into many a stocking. That then is a pleasure in store, for Mr. Robertson Scott, the founder of *The Countryman* and for twenty years its editor, has made a most enjoyable selection of past contributions to that family favourite and re-presented them in a book of 300 pages. Among more than a hundred contributors there is a host of notable people, past and present, not least four Prime Ministers—Lord Baldwin, Mr. Ramsay Macdonald, Mr. Neville Chamberlain, and Mr. Attlee.

Articles, notes and obviously considered trifles range over a multiplicity of rural interests. Sir Miles Thomas will win the hearts of many housewives with his suggestions for a "kitchen paradise". "One pities the bird in a gilded cage," he says. "Our housewives are just as imprisoned but their cages are begrimed with soot, covered with dust and thick with grease from out-of-date, ill-designed cooking equipment . . . A little intelligent planning in the kitchen can save the busy housewife several minutes per job and leave her less tired at the end of it." One doesn't need to go far to substantiate the truth of that assertion.

From too little imagination (on the part of the builder) we turn to too much (on the part of the villagers of Walkern), as evidenced by Mr. Raymond Walker's account of the alleged supernatural activities of Jane Wenham, some two hundred years ago. The old lady, over seventy, was condemned on a charge of witchcraft, but luckily, through the good offices of the judge, Sir John Powell, she obtained the Queen's pardon and lived to tell the story for another twenty years—a circumstance over which Jane doubtlessly often rubbed her bony hands in glee as she stirred her daily brew in the "cauldron"!

Earl Winterton describes the little-known religious sect of Cokelers, which, founded in 1850 by John Sirgood, a London shoemaker, has its headquarters in a corner of the Sussex weald. Writing fifteen years ago, Earl Winterton said: "Of an evening, in a quiet Sussex lane, one may suddenly come upon twenty or thirty Cokelers driving in waggons to their chapel, and chanting a sort of psalm, the men being dressed in dark clothes and the women in black dresses with poke bonnets. Total abstinence is no longer, as formerly, insisted on among the Cokelers, but it is encouraged. The sect, while recognizing the necessity of marriage, does not encourage that estate. It also eschews dancing, music, except of a religious nature, and flowers. A more honest, industrious and clean-living set of people it would be hard to find." In 1885 the sect had about two thousand adherents, but for many years now their numbers have been diminishing.

Among many notes on wild life, those on the ringing of migratory birds by R. M. Lockley, "How Birds Sleep" by Seton Gordon, Michael Blackmore's experiences with bats, and the dramatic story by D. Marion of bird murder by a praying mantis, will be read with interest. But it is the diverting vignettes of rural life such as "The Country Bus," "The Thatcher," and "Jarge has a Tooth Out" that touch this symposium with humour and the quality of humanity.

S. R. O'H.

Good Farming by Machine. H. J. Hine. English Universities Press. 4s. 6d.

It is good to see that the publishers of the *Teach Yourself Farming* series have not forgotten Farm Machinery. There are all too few books on the subject, and Mr. H. J. Hine's "Good Farming by Machine" is a welcome addition and will be of value to the new student of agriculture, to the man or woman who is being initiated into the mysteries of farming, and all those who wish to have a general idea of the shape and use of the common implements and machines found on the land.

The author does not attempt to explain the intricate mechanisms and critical settings necessary to enable a skilled farm worker to get the best out of his machines, probably because he knows that such knowledge cannot be imparted in a book. The book is notable too for the fact that in a few well-written paragraphs Mr. Hine defends the lack of care of machinery, with which farmers are so often charged.

The line drawings and the full descriptions under them are clear and admirably done and give a better idea of the construction and function of the machines illustrated than the rather indistinct half-tone pictures which are so often used.

In these days when there are so very many different machines used for the multifarious jobs on the land, and such a variety of models of each, one wishes that more had been said; but there is a limit to the length of any book, and the author has picked out that equipment, and its salient features, which will be of primary interest to the beginner.

The few errors which have crept in will undoubtedly be corrected in the second edition, which is likely soon to be in demand.

C.D.

BOOK REVIEWS

Town and Country Planning Law. J. Kekwick and Robert S. W. Pollard. Stevens. 4s.

Many of the statutes dealing with modern social services and nationalized industries are of concern not only, or even chiefly, to the legal profession, but also to officials of the central government and local authorities, business men and workpeople, householders and shopkeepers, professional men and trade union officials, and indeed the general public. The Town and Country Planning Act, 1947, is a statute of this kind.

Despite their widespread interest, many of these Acts of Parliament are exceedingly difficult to understand, even for the lawyer. This is especially true of Town and Country Planning legislation, which for some curious reason appears to be exceptionally complicated and obscure. It is therefore very desirable that simplified and reliable accounts of this legislation should be available for the layman. The present work is an excellent popular exposition of the great Act of 1947 in the series of handbooks entitled " This is the Law".

In just over a hundred pages the authors, who are well-known members of the legal profession, present a clearly-written and well-arranged statement of the principal provisions of the new statute. It is prefaced by a short introduction explaining the main purpose of the Town and Country Planning Act, a summary of its principal enactments and the administrative authorities who are responsible for carrying it into effect. A useful note on the new grants is contained in Appendix 1, while a second Appendix lists the matters which are to be prescribed by regulations.

It would be an exaggeration to say that the authors have succeeded in making the new measure easy to understand, but they have certainly made it much easier for the layman and the non-specialist lawyer to find his way about the Act. Officials and others concerned with agriculture are among those who will find this little book of great value.

W.A.R.

The Earth's Face. Ehrenfried Pfeiffer. Faber. 12s. 6d.

The Earth's Face is the plant-covered soil, and the author's main theme is soil destruction. He explains how the misuse of land has, within a lifetime, made vast fertile regions unproductive : every year the United States alone loses to the sea something like a thousand million tons of top soil—the only material on which plants will grow. A simple exposition of the causes and prevention of such capital losses is most welcome. Dr. Pfeiffer's diagnoses and advice on the problems of plains, forests, mountains, and human settlement, are sound and clear. Of the latter, he sees that "a suburban adolescence will simply develop differently according to whether it is passed between slums and city dumps, or whether it has satisfying natural surroundings". Sixty eloquent photographs most excellently support the text.

The book's purpose is, however, seriously divided: the facts everywhere are forced to carry the burden of the author's philosophy, and interest is disrupted in consequence. Where a practical theme, as here, has an epic nature, a poetic treatment may be welcomed, but the question may pertinently be asked whether it is necessary to allude to the "cosmic origin" of the plough, or to man as "the measure of creation". It seems, too, that when man took to drinking cow's milk, "a rent was torn in the spiritual history of mankind, and in that moment began economics"!

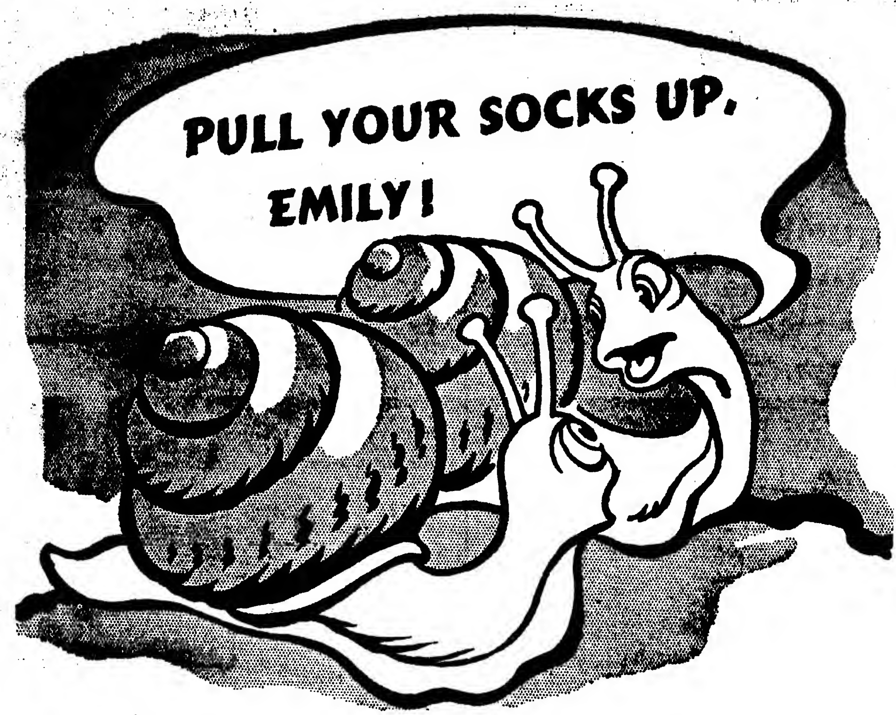
G.V.J.

Correction.

The Old House at Coate. Richard Jefferies, published by the Lutterworth Press and reviewed in last month's issue of *Agriculture*, is priced at 10s. 6d., not 7s. 6d. as quoted.

4572 Wt. 15 CN&Co 12/48 466

Please mention the JOURNAL *when corresponding with Advertisers*



"Get a move on, Emily. There's a Fordson Major just coming into the field and before we know where we are, all this ground will be ploughed up."

"Go on, Tilly, you're romancing."

"Romancing, my shell! There, look! what did I tell you? The Major's ploughed three furrows each way already. One Major can plough 6 acres a day, you know. With the improved Hydraulic Power Lift now available for all Majors, a Fordson can use a mounted plough and that means shorter headlands and all the ground covered. It also means quicker transport of implements from place to place. There's no doubt about it, a farmer gets more work out of a Fordson but it does make life a bit hectic for people like us . . . . ."

Fordson

the Major Power on the Land

FORDSON

FORD MOTOR COMPANY LTD., DAGENHAM, ESSEX

There's more than stock food in a BIBBY bag . . .

. . . there's everything that contributes to high quality and good value . . . extensive research both in our laboratories, and on our Experimental Farms . . . fresh raw materials straight from our own seed crushing mills . . . an extensive and well designed plant ensuring accuracy and economy in manufacture and a nation-wide and efficient distribution system direct from "mill to farm."

A part of the Silo Mixing Plant, Poultry Food Department.

BIBBY

J. BIBBY & SONS LTD LIVERPOOL 3

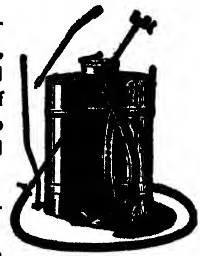
1190A

"MYSTO"

KNAPSACK SPRAYERS

. . . save TIME & LABOUR

. . Specially made for spraying Fruit Trees, Vines, Hops, Potatoes, etc., and for the destruction of Charlock—comfortable to wear, easy to operate and particularly efficient.



No. 1 model is for use with non-corrosive liquids.

No. 3 model for Corrosive Mixtures.

FROM YOUR LOCAL DEALER

★ We also make a complete range of **LIMEWASHING and SPRAYING MACHINES.**

W. T. FRENCH & SON LTD.

'MYSTO' WORKS - BIRMINGHAM, 16

STENT GRAIN STORAGE BINS

After this years weather every Farmer knows the importance of adequate Grain Storage. Heavily increased demands have proved the value of STENT GRAIN STORAGE BINS.

TO AVOID DISAPPOINTMENT PLACE YOUR ORDER NOW FOR 1949 HARVEST.

The Stent Bin is also suitable for Green Silage.

Our bins are suitable for installation in existing buildings; or we can supply Buildings and Bins complete. Send for prices and particulars NOW.

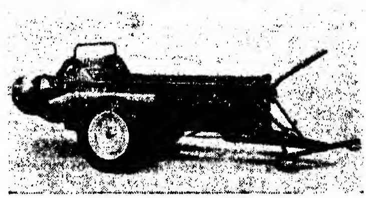
STENT PRECAST CONCRETE LTD

Sales: 1 VICTORIA STREET, LONDON, S.W.1
Phone: Whitehall 2573
Works: DAGENHAM DOCK, ESSEX
Phone: Rainham (Essex) 780

L2548

WINNING NEW CONFIDENCE
in British-built Farm Machinery

All the world over, leading farmers have a strong preference for MASSEY-HARRIS farming equipment, for there is over a century of experience behind every machine produced. At the Manchester plant of MASSEY-HARRIS LIMITED, modern farm machinery is being built which is the equal of any produced anywhere in the world. The No. 711 Tractor Spreader is specially designed and sturdily built for speedy tractor operation. Roller bearing equipped, the No. 711 is smooth working and light in draught.



No. 711 TRACTOR SPREADER

Latest type two wheel Spreader, specially designed for tractor spreading. Low body facilitates fast and easy loading. Five speed adjustments. Built-in screw jack enables quick adjustment to meet draw-bar of any tractor.

MASSEY-HARRIS LIMITED

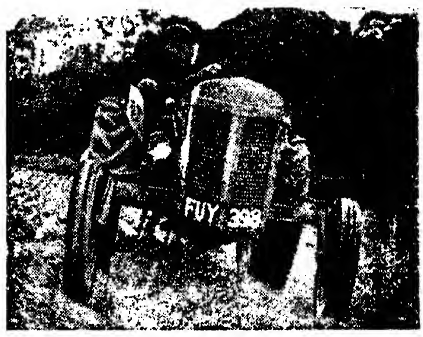
By Appointment to H.M. King George VI

MODERN FARM MACHINERY
BARTON DOCK ROAD · STRETFORD
MANCHESTER

Yorkshire Farmer Ploughs Motorcycle Test Hill

GRADIENT OF 1 IN 2½! This hill in Yorkshire used to be a test climb for motorcycle trials. It was thought too steep for ploughing. Now it has been successfully ploughed for the first time by a "Ferguson" tractor with a 10-inch 2-furrow plough working to a measured depth of 8 inches. The gradient is **1 in 2½**!

TRACTION WITHOUT BUILT-IN WEIGHT! 3-point linkage co-ordinates action of the "Ferguson" tractor-implement unit. Tractor automatically adjusts its weight to the job. You get more traction and the front wheels stay down. It's part of the "Ferguson System" of *complete* farm mechanisation.



SIMPLY BY AN ADJUSTMENT on the cross-shaft of the "Ferguson" plough, and by running the tractor front wheel spacing at 52", you can plough straight furrows of even width *across* hillsides. Ask your "Ferguson" Dealer for a demonstration on your farm.

FERGUSON SYSTEM

Farm Better, Farm Faster with FERGUSON

"Ferguson" Tractors are manufactured by The Standard Motor Co. Ltd. for Harry Ferguson Ltd., Coventry S.14

Please mention the JOURNAL *when corresponding with Advertisers*

72-1-12-48

Agriculture

PUBLISHED 6d MONTHLY

PROGENY TESTING PAYS

Our stock sells because we combine GOOD BREEDING with the HEALTHY conditions of the large arable farm. Write Dept. A

DAY OLD PULLETS

January

R.I.R. & L.S. 300/- per 100

R.I.R. x L.S.
Bl.L. x R.I.R.
Wht.L. x R.I.R.
Bn.L. x L.S.
} 280/- per 100

STOCK COCKERELS

R.I.R. & L.S. 2 to 5 guineas

F. & G. SYKES
ACCREDITED POULTRY BREEDERS
LAVERSTOCK · SALISBURY

Telephone: Salisbury 3315

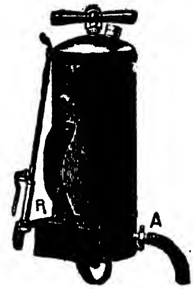
SPRAYING MACHINERY

For Applying all WASHES and DUSTS, LIME WASH, CREOSOTE and DISINFECTANTS.

There is a right machine for every job . . . ask a friend who is using a **Vermorel Sprayer.**

The "Noe-Leo" Pneumatic Knapsack Sprayer.

Pressure (up to 175 lbs. per square inch) is established before spraying work is commenced. Both hands are, therefore, free to direct the lance or hold aside foliage for spraying underneath the leaves. It is made of a Special Brass Alloy and may be used with Lime Sulphur in addition to the usual washes, and is fitted with Instantaneous Spray Control Lance. The **"Noe-Leo"** is filled by suction and the air pressure is retained when liquid contents have been sprayed. *This saves time and labour when recharging.*



"NOE-LEO" Knapsack Sprayer.

No.	Total Capacity	Liquid and Working Cap.	Pressure lbs. per sq. in.
7	4 gals.	2½ gals.	Up to 110
8	5 gal.	3½ gals.	„ „ 110
9	5 gals.	3½ gals.	„ „ 175

Prompt Delivery can be given of many types of Sprayers. Prices from 19/- to £422.

Catalogue and full particulars from

COOPER, PEGLER & CO. LTD.

Temporary Address: **"Delgenish," Chipstead, Surrey**

An ALKA contribution to the Government's QUALITY MILK POLICY

THE ALKA MSR54
SEMI-AUTOMATIC CAPPING MACHINE

This entirely new Alka machine, brings the advantages of rapid, safe and hygienic bottle sealing within reach of the smallest producer. Among its many outstanding features are the sealed plastic tubes in which the caps are stacked. Untouched by hand the caps are fed direct to the bottles, which are automatically sealed with a tamper-proof Alka aluminium cap embossed to customers' requirements.

The small illustrations show from left to right: the tube seal is broken, the holder is slid over the open end of tube, the tube with holder is inserted into socket on machine, which is now ready for use.

Write for full details to-day :—

ALKA LTD., MINERVA ROAD, LONDON, N.W.10.

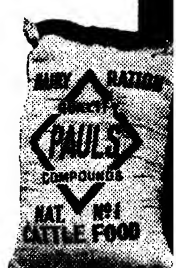
Quality

IN DIAMOND BRANDED BAGS

QUALITY FOODS for ALL STOCK

OBTAINABLE THROUGH YOUR LOCAL MERCHANTS

MILLS AT—
LONDON
FAVERSHAM
AVONMOUTH
MANCHESTER
HULL
KINGS LYNN
IPSWICH



R. & W. PAUL
LIMITED.

KOSITOS *The Flaked Maize*

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

Editorial Offices: St. Andrew's Place, Regent's Park, N.W.1 (*Phone: WELbeck* 7711)

VOL. LV — No. 10 — JANUARY 1949

Contents

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LV No. 10 JANUARY 1949

SEEDS MIXTURES: FALLACIES AND FACTS

SIR R. GEORGE STAPLEDON, C.B.E., M.A., F.R.S.

THE purpose of this article is to discuss the general principles which influence the drawing up of seeds mixtures, and I shall not concern myself with detailed prescriptions for particular purposes. I shall only deal with productive grass and not here revert to the question of browse([1]).

During the thirty-six years in which I have conducted experiments on seeds mixtures, there have been drastic changes in both theory and practice. It is difficult to reconcile the underlying views that led to, say, Robert Elliot's success with his "Improved Inner Kaimrig mixture," which consisted of seventeen species with a total seed rate of 48 lb. per acre, and an ultra-simple mixture of today consisting of no more than, perhaps, one strain of a single grass species with one strain of white clover and a seed rate of no more than 16 lb. and in extreme cases of no more, or even less, than 10 lb.

Earlier Guiding Principles I was brought up in the school that prescribed seeds mixtures on the basis of a simple rule of three sums—a school which overlooked the fact that biology, which deals with living things—almost every farming problem has a biological aspect—has a knack of making fun of conclusions based exclusively on the findings of either simple or, as we now know, of abstruse mathematical calculations. The idea was that you wanted so much ground covered by early, so much by late, and so much by mid-season species; so much by top and so much by bottom grasses, and that so many million plants per acre would be ideal. Having ascertained the laboratory germination, purity, and grain weight (= weight of 1,000 seeds) of the various seeds, you then calculated the number of viable seeds per lb. of the various species. With this information it is easy to calculate the weight of each species to be sown to give the desired proportion of ground covered and the total number of plants needed. It was all exceedingly simple, and exceedingly pretty on paper, but on the field it meant very little—very little for a number of significant reasons. Soil establishment is not the same as laboratory germination, and in comparing species one with another, it is not even proportionately the same. The figures here given, which are taken from Stapledon, Davies and Beddows ([2]), will illustrate this point:

	Laboratory Germination	No. of Viable Seeds per lb.	Establishment of Viable Seed	No. of Established Plants per 1 lb. of seed
	per cent		*per cent*	
Perennial ryegrass	81	187,000	56	103,000
Meadow fescue ..	82	140,000	38	53,000
Cocksfoot	79	308,000	37	114,000
Timothy	88	1,070,000	30	321,000

If then, on the basis of soil germination, we desire to establish as many plants of meadow fescue as of perennial ryegrass, we would need to sow twice as much seed of the latter as of the former. To put cocksfoot on level terms with the ryegrass, we would need to sow the seeds of both in approximately similar amounts, while to give timothy an equal chance the seed rate would need to be over a third as much as that of the ryegrass. In the older seeds mixtures the ratio ryegrasses (and Italian ryegrass behaves in a very similar manner to perennial) to the other species was overpoweringly weighted in favour of the ryegrasses. A great point in favour of the Elliot mixtures was that Elliot ([3]) seldom included perennial ryegrass; and when he did so, frequently no more than 1 lb., and when he included Italian he did not use more than 3 lb. His seed rate for cocksfoot varied from 6 lb. to 14 lb., and he more usually sowed 4-5 lb. meadow fescue. In his mixtures, therefore, cocksfoot was always given a fair start (and cocksfoot was the soul of his mixtures). Meadow fescue was in better case than if it had to contend with an excess of ryegrass, but, properly to contend with cocksfoot on the basis of soil germination, this species should have been sown in double the quantity of cocksfoot.*

The figures I have mentioned are based on soil establishment where the different species were sown alone in pure plots. But matters become altogether different when a number of species are sown together in the same mixture. Here again, the early work at Aberystwyth is extremely evidential. This evidence is discussed at length by Stapledon, Davies and Beddows ([2]). It is shown that Italian and perennial ryegrass interfere strongly with the establishment of all other grasses. When these (either singly or together) are included in mixtures with meadow fescue, cocksfoot and timothy, cocksfoot suffers least but is much depressed; meadow fescue and timothy are reduced to exceedingly poor establishments, of the two species timothy suffering the greater. In mixtures without the ryegrasses it would now seem that the competitive reaction between cocksfoot and meadow fescue varies considerably with the conditions, but that both species are usually aggressive towards timothy. In view of the fact that mixtures are now often sown without a cover crop, it is significant to note that the ryegrasses are far more aggressive towards the other three grasses than is a cereal cover crop. Sown in a competitive mixture without a cover crop and without ryegrasses, meadow fescue gave rather better establishment than did the two ryegrasses taken together, when these were sown under similar conditions and in a competitive mixture. The data as a whole show that the two ryegrasses are decidedly inter-competitive. They were in fact more mutually destructive than were meadow fescue and cocksfoot when the latter were not set to compete with either ryegrass. Inter-specific competition commences almost at once in competitive seeds mixtures and in a manner favourable to the ryegrasses. In the first instance it has been shown ([4]) that the seeds of these grasses are less sensitive to conditions of weather and tilth and to depth of sowing than are other species. The seedlings, and particularly those of Italian ryegrass, also grow away more quickly and will tend from the outset to out-top other seedlings, and in the first few weeks to produce a greater bulk of young leafage. In the earliest stages cocksfoot seedlings grow faster than those of meadow fescue or timothy. At a later stage (after about seven weeks) the growth of cocksfoot and meadow fescue becomes practically as rapid as that of even Italian ryegrass, and timothy also grows at an increasing rate.

The evidence we have discussed bears crucially on the question of seeds mixtures; and on the face of it it is wholly in favour of the non-competitive

* In his first Inner Kaimrig mixture Elliot used 6 lb. of cocksfoot and 5 lb. of meadow fescue, which at least gave the latter a better start.

simple mixture. It shows why it is so essential to graze mixtures including either of the ryegrasses, sown without a cover crop at an early stage, and this irrespective of the importance of consolidation. It also shows why meadow fescue, when included in mixtures with the ryegrasses and under a cereal cover crop (the standard method for so many years), never did itself justice. Meadow fescue appears now to be coming into its own, for it is being sown either as the only grass with white clover or in conjunction with timothy against the seedlings of which grass it can compete on at least equal terms. An interesting point arises in the case of simple mixtures sown without a cover crop and without competition with the ryegrasses, and where if two grass species are included they are not strongly inter-competitive in the earliest stages. The evidence in the paper I have discussed suggests that to get the best yields in the year of sowing, grazing should not be started too early. We have all got into the habit of grazing both competitive and non-competitive non-cover crop mixtures at the earliest possible moment in the interests of consolidation and establishment. Where the consolidation has been adequate at the time of sowing, as it always should be, I am sceptical as to the wisdom of this as affecting the ultimate vigour of the ley. In an experiment I put down last May, I did not graze until nearly ten weeks after sowing. My establishment is all that could be desired, and my maiden yields from the cocksfoot-white clover and from the meadow fescue-white clover plots have compared most favourably with those sown respectively with Italian ryegrass and alsike clover and with perennial ryegrass and white clover; and although my grazing was deferred and at no period has been particularly hard, I have achieved perfectly good establishments of S.100 white clover.

Use and Duration of Leys The precise use to which a ley will be put and the number of years it will be left down are the most important of all considerations in the drawing up of seeds mixtures. Now that we have pasture strains (relatively slow starters) and hay strains (more rapid starters) to choose from in respect of the chief grasses, both "use" and "duration" become of greater significance than ever. In my view it is always necessary to distinguish between leys intended to be left down respectively for (a) one year or less, (b) two years, (c) three years, (d) four to five years, and (e) over five years.

As to use, the most important points to be considered are:

(*a*) whether hay will be taken; *or*

(*b*) whether the ley will be used only for grazing*; If hay will be taken it must be considered whether:

- (*c*) it will be so taken during each year of the life of the ley;
- (*d*) only in the first year;
- (*e*) after the first year; and
- (*f*) not until the third year or at no pre-defined period.

Where hay is an important consideration it is always necessary to cater separately for a single bumper hay crop or for a good hay crop to be followed by a wealth of aftermath and, whether or not the aftermath will be grazed, cut for silage or allowed to run on to a second cut for hay.

The more rapidly growing "hay" strains of any particular species will tend to suppress the slower growing "pasture" strains of the same species from the outset, and this suppression will tend to be increasingly serious in proportion to the amount of the growth which is allowed to develop. Different

* It is legitimate, indeed desirable, to take silage cuts from grazing leys if the growth of the herbage runs away from the animals.

strains then behave towards each other precisely in the same way as do different species. From this fundamental fact two overriding principles emerge; and they are principles which it is the more dangerous to ignore because the farmer can never time the cutting of his hay to a day, nor regulate his grazing to a nicety. The principles are: (1) hay and pasture strains, or quick- and slow-starting species, should not be blended in mixtures from which hay will be taken in the first year or regularly thereafter; (2) hay and pasture strains and quick- and slow-starting species should not be blended in grazing mixtures unless it is reasonably certain that the grazing will be controlled properly in the seeding year and during the first and second harvest years. No risks should be taken in respect of the longer duration leys, i.e., upwards of three years. For leys of four to five years only intermediate and pasture strains should be used, and for those of upwards of five years, only the best and most long-lived of the pasture strains.

The same general principles apply to clover as to grass strains. Thus broad red clover is at its legitimate best for one-year leys and should be included in two-year leys only if aftermath in the first year is of outstanding importance. English late-flowering red clover is correct for two-year leys. The extra-late red clovers like Montgomery, Cornish marl, and S.123, should have it all their own way in leys from which it is intended to take hay three years in succession; although on soils that suit it, the lucerne-cocksfoot, timothy or meadow fescue ley would be justified for a duration of no more than three years. The S.100 strain of white clover is competent by itself to take care of leys of three years' duration; those of four to five years should also include wild white, and for those of upwards of five years it is best to sow only wild white clover. To supplement the points I have made, I will add a few notes on certain selected aspects of leys for each of the durations here mentioned.

One-Year Leys. If the chief consideration is one heavy hay crop, then perennial ryegrass should be used to the exclusion of Italian. If aftermath (as hay or grazing) is of equal importance, then Italian should also be included, despite the fact the two ryegrasses are mutually destructive. Timothy will give a very heavy single hay crop, but (because it is a late grass) it should be grown with alsike or English late-flowering red clover rather than with broad red clover.

Two-Year Leys. Ordinary American or Scotch timothy with an English late-flowering red clover will give heavy crops of hay in both years; so would Danish cocksfoot and late-flowering red clover or Irish perennial ryegrass and late-flowering red clover. The Aberystwyth S.24 perennial ryegrass would justify itself for a two years' hay-ley, especially where aftermath grazing is an important consideration. I would always advocate the use of S.24 (as the only ryegrass strain) for a two-year grazing ley, and I would also depend upon New Zealand large white clover or S.100 rather than use wholly or in part a more Dutch-like strain.

Three-Year Leys. For hay in each year I would rely upon either S.24 perennial ryegrass or S.37 cocksfoot with Montgomery, Cornish marl or S.123 extra-late red clover; or I would use S.48 timothy and a good Danish or Aberystwyth strain of meadow fescue—which will greatly assist the aftermath grazing—with the extra-late clover.

Four- and Five-Year Leys. Hay should never be taken in the first or second harvest year from leys intended to be left down for more than three years, and I would never include Italian ryegrass in such mixtures. As duration is extended it becomes risky to rely upon one-grass-species-white clover mixtures. The timothy-white clover mixture should always be

supplemented with meadow fescue. Five species mixtures with worthwhile amounts of each can be established and maintained if the seed rates are based on the principles I discussed at the beginning of this article, and the grazing management (supplemented if necessary by silage cuts) is of a high order. The chief rule to conform to, over and above those previously discussed, is to put perennial ryegrass (and S.23 only should be used) at a decidedly lower seed rate than cocksfoot or meadow fescue or timothy—3 to 4 lb. per acre should be regarded as the maximum quantity.

Five-Year and Longer Leys. Although under conditions of high fertility the perennial ryegrass (S.23) and white clover ley might hold well for over five years and the cocksfoot*-white clover mixture do the same on "cocksfoot" soils, in general, when we get over five years (and often over four) it becomes desirable to introduce other durable species into the grazing mixtures. It must be borne in mind, moreover, that leys will not be expected to stay down for more than three to four years, except where the conditions are peculiarly difficult. In my view crested dog's tail, the extreme pasture type of timothy S.50, and the red fescue S.59 should be regarded as particularly valuable sorts with which to strengthen these long-duration grazing mixtures. Sensible seed rates when either of these species is included in a mixture would be: crested dog's tail 3-4 lb., red fescue 2-3 lb. and timothy 4-5 lb. Meadow fescue, once it is well established, is a decidedly long-lasting species, perhaps particularly so on rather heavy soils. There is need for much further research relative to these truly long-duration leys, for they have a definite place to fill in our farm practice and agricultural economy.

Conclusion In the space available I have been able to deal only with some of the more important considerations influencing the blending of mixtures. I think, however, that I have said enough to show that "use" and "duration" are the overriding factors, and that it is both unscientific and not in the interests of the best practice to suppose that the manifold conditions which the farmer has to meet can be covered by suggestions made in terms of comparatively few type mixtures. The type mixture implies that ley farming is standardized more rigidly than in fact it is, or than it is desirable that it should be; and it also implies that our knowledge of needs, means and modes is altogether greater than it is. We are still in the position where it is far more important to encourage exploration on the part of farmers than to preach standardization.

References

1. STAPLEDON, SIR R. GEORGE. Pastures Old and New. *Agriculture* (1948) **55**, No. 6.
2. STAPLEDON, R. G., DAVIES, WM. and BEDDOWS, A. R. Seeds Mixture Problems. *Welsh Plant Breeding Station* (1927) Bull. Ser. H., No. 6.
3. ELLIOT, ROBERT H. The Clifton Park System of Farming. Faber (1943).
4. STAPLEDON, SIR R. GEORGE and WHEELER, DOROTHY E. An Experiment to Test the Influence of Depth and Date of Sowing on four of the Chief Grasses and on White Clover. *Journ. British Grassland Soc.* (1948) **3**, No. 4.

* Chiefly S.143.

HAYMAKING AND GRASS DRYING SURVEYS

C. R. ROBARTS and L. G. TESTER
National Institute of Agricultural Engineering, Silsoe, Beds

MOST farmers believe that their own way of growing or harvesting a crop is the most suitable for their farm, but none can be certain, and few can afford to experiment with other methods or even possess the means to enable them to compare different methods scientifically. Fortunately there are several organizations which study methods of farming in different parts of the country.

One of these, the Farm Mechanization Enquiry of the National Institute of Agricultural Engineering, has been working since 1944, and its general aim is to obtain accurate information on the way machines are used under farm rather than ideal conditions. Recorders visit farms in representative districts of Britain and, without interrupting the normal farm work, take note of such things as the time and labour needed for each operation, the records being sent to the N.I.A.E. for collation and analysis. Recent work carried out by the F.M.E. has included inquiries into grass conservation, and surveys have been made on haymaking and grass drying.

Haymaking The haymaking survey took place in Wiltshire, Yorkshire, and Scotland, to enable three main methods to be studied: piking, cocking, and the method generally practised in southern England where the hay is made as quickly as possible direct from the windrow.

Among the farms visited were those on which the hay was stacked loose and those on which it was baled before being stacked. Little hand labour was used in Wiltshire, the hay being both turned and side-raked into windrows by machine, and either taken to the stack by sweep, or trailer and pick-up loader, or baled with a fully automatic pick-up baler. In Wiltshire the weather was fine during the period of the survey, but in Yorkshire the weather was unsettled. The hay in Yorkshire was turned by hand but side-raked mechanically and then either swept or carted to the stack or stationary baler. In Scotland haymaking was a month later than in England and the weather was fine and sunny. Most of the hay was hand-turned, as a large labour force was already necessary for piking. The pikes were left in the field for about a fortnight and then loaded on hay bogies and taken to the stack or stationary baler.

The method of haymaking practised in Wiltshire was the quickest and most economical of man-power, requiring an average of 7.5 man-hours per acre when the hay was stacked loose, and only 2.7 man-hours per acre when the hay was baled. The corresponding figures in Yorkshire, where the hay was cocked, were 10.7 and 8.5 man-hours per acre, while the Scottish method, where the hay was piked, was the slowest and the least economical of man-power, requiring respectively 27.4 and 19.8 man-hours per acre for loose and baled hay. Piking required many man-hours and a large labour team, but it was the most independent of weather conditions and probably the most suitable for heavy crops. Cocking required less man-hours than piking, but the cocks were not so weatherproof as the pikes, although they dried out fairly quickly after rain if the weather was fine.

Analyses of individual operations showed that a 6-feet direct-attached tractor mower was able to cut twice as many acres per hour as a 4-feet trailer-mower and nearly three times as much as a 4-feet horse-mower. Sweeping was the quickest way of collecting loose hay, while the use of a hay loader showed no appreciable advantage in time over hand-loading. When the hay was stacked in the field, pikes were dragged more quickly by one man and a tractor than by three men and three horse-drawn bogies. Hand pitching was the fastest method of stacking loose hay, being slightly

faster than when an elevator was used and considerably faster than with the use of a mechanical hay fork. The automatic pick-up baler maintained a higher output than the stationary baler, and was more economical of man-power. It was, however, used on light crops and might not have been so suitable in areas of heavy rainfall, as in Scotland, where it is often difficult to dry out hay in the windrow.

The moisture content of the hay was determined at different stages of haymaking, and it was found that it was generally reduced to approximately 16 per cent before the hay was stacked. On one farm in Yorkshire the hay was stacked at a moisture content of 23.4 per cent, but this practice involved a risk of the hay becoming mouldy. The survey confirmed that in the south of England recently developed hay-making machines such as the pick-up baler are able to speed up the work considerably. The survey did not reveal whether piking is essential in Scotland, and, if so, whether the operation can be mechanized.

Grass Drying The survey on grass drying was divided into two studies, a preliminary study being of 123 grass drying plants from which 10 driers were chosen for a detailed study of performance and working technique. The preliminary study did not include all the drying plants in England and Wales, but it is believed that the number was sufficiently large to make the sample representative of the types of driers and their methods of working. Approximately two-thirds of the driers were tray driers, the remainder being of the more recently developed conveyor type.

As grass constituted more than 90 per cent of the green crops dried in Britain, it would be reasonable to suppose that most of the driers would be in grassland areas, and this was confirmed by the survey, the chief exception being Norfolk where a crop drying industry has been built on the use of temporary leys and lucerne. In areas with an average rainfall of under 25 inches, less than half of the acreage of crops grown for drying was lucerne. In areas with between 30 and 40 inches of rain, only 2 per cent of the acreage was lucerne, while in areas with an annual rainfall of more than 40 inches, lucerne was not grown at all for drying.

The average annual output of the driers was 200 tons, but the output varied considerably according to the rainfall of the districts. In areas with 20–25 inches of rain a year, for instance, the average output was 307 tons, while in areas of between 50 and 60 inches of rain the average output was only 36 tons. The difference can probably be accounted for by the fact that in the areas of low rainfall, grass drying was often considered to be the most important activity on the farm and consequently high yielding, drought-resisting crops were specially grown, whereas in the wetter areas, grass drying was regarded merely as part of the farm routine, and only as much grass was dried as could be consumed on the farm. Other reasons why a greater annual output was obtained in areas of little rainfall were probably that the grass could be cut at a lower moisture content, and that the more favourable weather gave the drier users a better opportunity of allowing the grass to wilt.

The difference in performance caused by allowing grass to wilt before it was fed to the driers was studied and it was found that a reduction in the water ratio of from 3.2 : 1 to 1.6 : 1 resulted in an average increase in output of 1.9 cwt. an hour and a decrease in coke consumption of 5.5. cwt. per ton of dried material.

Nearly half the driers started drying during the first two weeks in May, and although the grass drying season continued until September,

each drier worked an average of only 71 days during the season, because it was not possible to provide a constant supply of grass throughout the whole season. The usual length of working day was 14 hours, but this figure was increased by only one hour at flush periods, much of the extra yield of grass being made into hay or silage.

Different methods of harvesting the grass were practised, cutter-loaders being used with about one-third of the driers and pick-up loaders with about half of them. At the smaller plants, cutter-loaders were less common, probably because the farmers had greater control of wilting, and they preferred to use machinery that could also be used for haymaking. The average rate of work with the cutter-loader was the highest of all the methods of collection. Much time was spent, however, hitching and unhitching trailers, and on some farms one tractor was used both to harvest the grass and to take it to the drier several fields away. Consequently, one man was left in the field and, although when working with a pick-up loader he was able to hand-windrow the grass ready for the next load, there was little he could do while the grass was being transported to the drier when a cutter-loader was being used.

The total time that the driers were idle was not high and amounted to an average of approximately 12 per cent of the overall time, although that of large conveyor driers was nearly 20 per cent. The chief causes of idle time were warming up and maintenance; other causes were the field equipment working at a slower rate than the drier, and the clearing up necessary at the end of each day. Feeding the wet grass to the drier and, with tray driers, moving it from one tray to another during drying, occupied about one-third of the man-hours.

The size of team was usually two or three men with a conveyor drier, and three or four men with a tray drier, a more economical use of labour being possible when more than one drier was operated at the same plant. A saving in labour was possible with oil-burning furnaces, and also with solid-fuel furnaces when automatic stokers were fitted.

Most of the driers used solid fuel, coke being most common, although some furnaces burned anthracite and others coal. Anthracite evaporated more water per lb. of fuel than any of the other fuels; oil was second best. Attending to hand-stoked solid-fuel furnaces required slightly more than 6 per cent of the total man-hours, but this percentage was reduced by more than half when automatic stokers were fitted; oil furnaces required less than 1 per cent of the total man-hours.

At some of the driers almost all the grass dried was sold, but at the majority about 60 per cent was retained. The dried grass was usually baled if it was to be consumed on the farm, because of the ease of storing and handling; it was usually milled if it was to be sold, because milled material was cheapest to transport and most readily incorporated in other feedingstuffs. On nearly half of the farms dried grass was both consumed on the farm and sold, and the equipment included both a baler and a mill. Bales were stored most frequently in Dutch barns, sides often being added as a protection against light and weather. Milled dried grass was usually stored in a building near the mill and sufficiently large to hold a week's output.

SURPLUS POTATOES FOR STOCK FEEDING

H. G. Robinson, M.Sc.
University of Nottingham, School of Agriculture, Sutton Bonington

IT is an interesting fact that stock-feeders over a hundred years ago were apparently more familiar with the use of potatoes for animal feeding than we are today. The crop was then comparatively new and a considerable amount of experimentation had been undertaken by landowners and farmers at the end of the eighteenth and in the early years of the nineteenth centuries. In Vol. I of the *Annals of Agriculture*, published in 1784, there is a letter from H. G. Close of Trimley extolling the virtues of potatoes as a foodstuff for both pigs and cattle. The writer of the letter records that he had substituted potatoes for cabbage in the feeding of three milch cows from the second week in March until the second week in May without any diminution in milk yield. The quantity fed amounted to half a bushel of potatoes per cow each night and morning. The inducement to feed potatoes resulted from the fact that the cattle showed their fondness for them when they were thrown out to the pigs. Potatoes and hay *ad lib.* sufficed for the animals in question.

In the same journal a Mr. John Bywell of Agglethorpe reported that potatoes were superior to turnips in the feeding of cattle and were also suitable for feeding to milking cows. He also claimed them to be good for working horses if fed at the rate of half a peck a day with hay. Actually very little has been added to our knowledge of the potato as an animal feedingstuff in recent years, and modern experiments have served only to confirm the findings of the early pioneers. The potato is not normally grown for stock and begins to attract attention as a suitable feedingstuff only when, as now, a superabundant crop exceeds human requirements.

A Rich and Relatively Cheap Feedingstuff

The value of a home-grown food must be judged not so much from the price per ton which it commands but by its digestible nutrients, and in this respect the potato ranks high. Any attempt to compare the potato with other root crops must always take into account the fact that it is about twice as rich in dry matter as mangolds and swedes, and its relative superiority in starch equivalent is nearly three times as great. Neither is it greatly different from the other root crops in respect of protein content, which is relatively low. The functions of the potato as a food for livestock are therefore associated most closely with the needs of fattening. This does not imply that the potato is a food that can be fed only to fattening animals; it can well supply part of the starch equivalent needed by a working horse or a dairy cow.

Most farmers know that the potato is not an entirely foolproof food, but this aspect has been rather exaggerated. Thus it is common knowledge that the potato plant contains solanin, a nitrogenous glucoside with slightly poisonous properties, but this is found chiefly in the haulm and only very slightly in the tuber, except when the tubers have been greened by exposure to the light. When the tuber sprouts the solanin passes into the sprouts. It is for this reason that long experience and custom have led to the practice of de-sprouting potatoes before they are fed to livestock in the raw state. The cooking of the potato tuber by boiling, steaming or roasting drives off any poisonous properties, and some four years ago, in an experiment at Sutton Bonington, pigs were fed successfully on green and well-sprouted seed potatoes that had been steamed before being used.

The other fact to be noted concerning potatoes is that when fed raw they have a laxative effect, but this usually results from not gradually accustoming livestock to a change of food (a common fault) and not recognizing that the potato is a more concentrated foodstuff than other roots. The use of dirty, diseased tubers is also likely to produce digestive disturbances when they are fed in the raw state. It is for this reason that the steaming or boiling of potatoes has been recommended to ensure the best results with most classes of stock—especially pigs. Moreover, cooked potatoes are not laxative. For horses and cattle, sound, raw potatoes are quite wholesome and satisfactory, though it is better to feed them sliced rather than whole.

Potatoes for stock feeding are relatively cheap, and that many farmers are ready to use them is shown by Ministry of Food sales. It is probable, however, that the greater part has been given to pigs and poultry. Ever since 1938, potatoes have been used extensively in feeding the herd of Large White pigs at the University of Nottingham School of Agriculture, but they have always been steamed. Our results tend to confirm experience in Denmark, where 4 lb. of cooked potatoes are regarded as equivalent in feeding value to 1 lb. of barley meal.

Meal-Fed and Potato-Fed Pigs in Bacon Competition

The early work on potato feeding to pigs at Sutton Bonington was described by a former colleague, Stephen Williams, in this JOURNAL.* Since then pig feeding difficulties have increased with the inability to get the normal supplementary foods, and the feeding methods described by Williams have had to be adjusted to the changed circumstances. The present practice on the University farm at Sutton Bonington is to feed the pigs on an all-meal ration until they reach 80 lb. live weight. A typical mixture is:

	cwt.		*cwt.*
Fine offals	2½	Dredge corn	1
Coarse offals	2½	Dried grass	½
Barley meal	1½	Pea meal	½
Maize meal	1	Fish meal	½
Flaked maize	1		

This meal mixture is fed to appetite. When the average live weights of the pen reaches 80 lb., the pigs are changed over to a ration of 2 lb. each daily of the following mixture:

	cwt.		*cwt.*
Fine offals	1½	Dredge corn	1
Coarse offals	1½	Pea pickings meal	1
Barley meal	1	Dried grass	½
Flaked maize	1	Fish meal	½

In addition, steamed potato silage is fed to appetite. At first the quantity of potato silage consumed amounts to 2-4 lb. per head daily, but in the later stages of fattening it may reach 16-20 lb. per head daily.

As a matter of interest, Sutton Bonington made three entries in the bacon competition organized by the National Pig Breeders' Association at Peterborough last autumn. One of the entries was fed on the system outlined above and the other two were fed on an all-meal diet, though the latter had to be varied month by month because irregular supplies prevented a constant ration being maintained. Yet the potato-fed pig compared very favourably

* 45 (1939), 1218.

with the two meal-fed pigs on carcass pointing, as the following figures indicate:

	Perfect Score	Meal-fed Exhibit	Meal-fed Exhibit	Potato-fed Exhibit
Proportion of back fat	15	15	10	15
Thickness of streak	10	7	6	8
Length for weight	10	10	8	8
Proportion of cuts	10	8	6	7
Shape of gammon	5	4	4	4
Reduction of back fat from shoulder to gammon	5	5	3	4
Fineness of bone	5	3	4	3
Thinness of rind	5	4	4	4
Quality of flesh (fineness and whiteness of fat)	15	10	12	11
Proportion of lean to fat on cut side ..	20	16	15	15
	100	82	72	79

Steamed Potato Silage at Sutton Bonington The whole of the normal pig fattening activities at Sutton Bonington are related to the use of steamed potatoes and steamed potato silage. In the past summer, for example, some 275 tons of unwanted seed potatoes were purchased from the Ministry of Food and converted into steamed potato silage. The handling of such large quantities has been facilitated by the use of a large trailer lined at the sides with iron sheets and having a perforated bottom. A tight-fitting lid is clamped on to the trailer through which steam is admitted from a supply generated by the steam-raising plant installed in the power-house. About 45 to 50 cwt. are steamed at a time, which takes about 2½ hours, and the steamed potatoes are then transferred to any suitable containers available. The trench type of container with two parallel oblique walls is still considered to provide the most effective storage. This allows for good consolidation and limited exposure to the air.

Other containers have been used, including the round silos employed for forage, but the trouble with these is that the material does not pack so well if the silos are wide, while wastage is increased on opening the silo for feeding purposes if too great a surface area is exposed. It is important to stress that there is little or no wastage, provided the potatoes are well trampled and the container narrow.

Potatoes ensiled with Forage Crops There is nothing new in the ensiling of potatoes, though the method practised at Sutton Bonington has made use of large-scale steaming facilities which are not readily available on every farm. Much work has been done elsewhere, however, on the adoption of more natural methods of preservation. In the June, 1897, issue of this JOURNAL a reference was made to some French experiments on storing potatoes in silos. The investigation in question sought to ascertain whether the heat generated by the fermentation of fodder plants in silos could be utilized for preserving potatoes. The fodder used was crimson clover (*Trifolium incarnatum*), and potatoes were added in the course of filling the silo. A very satisfactory product resulted, in which the potatoes acquired the colour of the crimson clover, were considerably flattened by the pressure of the silage, and the heat generated (160° F.) had effectively cooked them. This method of making potato silage, as referred to by J. C. Wallace in this JOURNAL in January, 1930, has been widely followed in Holland, especially in the glut potato year of 1928-29. The procedure is to mix newly-mown pasture grass and potatoes in round

stack silos with a diameter of 12-15 feet, building up with alternate layers of grass and potatoes in the proportion of about 30 cwt. of green grass to 10 cwt. of potatoes. On completion, the stack was sealed with soil to the depth of a foot or so.

Wallace and Thompson in this JOURNAL for December, 1931, summarized the results of experimental work on the making of potato silage at the Agricultural Institute, Kirton, when tubers from the 1929 crops were made into silage in May, 1930, by admixture with forage from a red clover and ryegrass seeds mixture in a very similar manner to the Dutch custom. The resulting product was fed very satisfactorily to fattening bullocks in the following winter, and this particular method of conservation can be regarded as being suitable for cattle feeding needs in general, but it is not suitable for pig feeding.

Ensiled Raw Potatoes There is yet another method of making potato silage, which originated in France, where raw potatoes are placed in a silo or trench. The French method utilizes about 2 lb. of salt per 1,000 lb. of potatoes, which are chopped or sliced. The resulting potato pulp is said to retain its whiteness, though parts exposed to the air blacken slightly after opening the silo. A similar method is used in Holland, and the product is highly valued as a feedingstuff for winter needs, even of dairy herds. On a visit to Holland in June, 1939, I saw a large quantity of raw potatoes being stored in a pit on the farm of one of the best known breeders of Friesian cattle in Friesland. The method adopted was to slice the potatoes with a hay knife as they were put into the pit. They were then well-trampled and earthed over.

It is thus obvious that owners of livestock faced with the problem of finding adequate supplies of feedingstuffs can with advantage make use of surplus potatoes. The methods of preservation discussed here have been well tried, but there are equal opportunities for using fresh potatoes for livestock. In the raw state they have their greatest use in the feeding of cattle. Kellner suggested that the appropriate quantities to feed to fattening cattle were at the rate of 50 lb. per 1,000 lb. live weight, while cows in milk could receive half this quantity.

No reference has been made to the use of potatoes for sheep, but the old records provide abundant evidence of their use for this class of stock, and Kellner confirmed that sheep take raw potatoes almost as well as cattle and suggested that on a per 1,000 lb. liveweight basis similar quantities could be fed as for cattle. Kellner also suggested that 3-5 lb. daily of raw potatoes could be utilized adequately and beneficially by horses.

UNRATIONED FEEDINGSTUFFS

Alan H. Ward, B.Sc., A.R.I.C.
Aynsome Laboratories, Grange-over-Sands, Lancs

UNRATIONED feedingstuffs have had an artificial value since the beginning of the war. With the introduction of rationing and the scarcity of normal feedingstuffs, any additional food provided a welcome alternative to reducing the stock. The demand for off-the-ration foods inevitably led to a certain amount of profiteering, and materials of very dubious value were offered for sale, often at extravagant prices. Nevertheless some unrationed foods have an undoubted value and it would be unreasonable to condemn them all. The discriminating stock-keeper would choose those of the best value and avoid others that contribute little or nothing to the nutrition of the animals.

The origin of a material usually provides a good indication of its value. Seed screenings, for instance, may include a large proportion of the sand and dirt naturally associated with the original seed. Sack shakings and sweepings are apt to contain sack fibres and sundry other extraneous materials.

Any substance of obviously fibrous nature needs special care in feeding, since animals possess no cellulose-splitting enzymes, the breakdown of fibre being a process of bacterial fermentation. Bacterial action plays an important part in the digestion of ruminants and horses but is negligible in pigs, poultry or other animals having relatively simple digestive systems. For the latter, excessive fibre—merely so much indigestible bulk that will actually detract from the nutritive value in the ration; in other words, foods high in fibre can have a negative starch equivalent because the energy required in passing the material through the digestive tract, together with the heat lost in the undigested residue, may be greater than the available energy in the assimilable portion. On the other hand, the bacterial population in the digestive system of ruminants enables them to make quite efficient use of fibre. Foods of this type would approximate to straw in feeding value, but to be economic should also be comparable in price.

Unrationed feedingstuffs fall into several categories, which, for the purpose of this article, may be classified roughly into six categories.

1. Foods available in Small Quantity and produced in Small Lots These usually are perfectly sound feedingstuffs, but owing to their limited supply the trouble involved in bringing them under control would not be justified. Under this heading may be listed materials such as dried yeast, dried blood, locust bean germ, biscuit meal, bakehouse sweepings, residues from cheese, meat and yeast processing, condemned dried egg, and cocoa by-products. These are materials with definite feeding value and comparable with rationed feedingstuffs. Locust bean germ, for example, may contain about 45 per cent protein and be equivalent to a high protein oil cake of the type of decorticated cotton cake or groundnut, for feeding to any type of stock.

Biscuit meal and flour waste generally have a feeding value similar to flour or to ground cereals such as barley meal. If in sound condition, confectionery and flour waste is suitable for all stock but preferably for adult pigs or poultry. It is wise to inspect each consignment before accepting it and to sieve it through a fairly fine mesh before feeding, because of the presence of such material as string or lumps of hard dough. The presence of self-raising agents can be detected by the evolution of gas on the addition of water. Treated flour should be used sparingly and preferably damped some time before feeding. In one interesting case last year, some poultry

had been fed with self-raising flour and the continued production of gas in the stomach resulted in considerable losses.

Cheese, meat and yeast residues naturally are valuable materials, often high in protein and sometimes in oil. These make suitable supplements for pigs and poultry, as they may also have a fairly high vitamin content. A word of warning is necessary, however, because any of these products may contain a large amount of salt, which would render them poisonous to both pigs and poultry. The presence of salt can easily be detected by taste, or by analysis if necessary. Any salted foods should be reserved entirely for adult cattle or used very sparingly in rations for other stock.

Dried yeast is an excellent high protein supplement, rich also in vitamins of the B complex. It has a protein equivalent approximating to that of groundnut cake and is an excellent supplement for young stock because it will go a long way towards supplying their requirements of riboflavin and other B vitamins. Two-and-a-half to five per cent of dried yeast in chick food or weaners' ration would enhance the nutritive value and lead to economy in protein coupons. Dried yeast may also be fed to adult cattle, pigs or poultry up to about 10 per cent of the ration, in replacement of other high protein materials.

Dried blood is the richest protein food available, averaging about 80 per cent protein ; it is fairly easily digested and the biological value is good. In general, 2½ per cent of dried blood could replace about 5 per cent of other protein concentrates in rations for any type of stock. The material must definitely be of feeding quality and not intended for fertilizer, since any contamination with disease organisms could easily lead to serious trouble on the farm.

Dried egg powder condemned as unfit for human consumption is of rather infrequent occurrence, but where available it is an excellent source of fat, protein, and vitamins. Because of its high price and relative scarcity it would, of course, have to be fed with great economy, as in fact would be necessitated on account of the high fat content which otherwise would give rise to digestive disorders. About 2½ per cent of dried egg powder in any poultry food or in a ration for growing pigs would be a very desirable supplement.

Cocoa by-products were largely used at one time as conditioners in fertilizers, but under present conditions some are diverted to the feedingstuffs trade. They have a good feeding value, although this is offset by the presence of theobromine, a toxic alkaloid. Under present regulations, cocoa by-products may be used only for feeding if the theobromine content is under 1.3 per cent and, even so, stock-keepers should feed them to adult cattle only, at a rate not exceeding 2 lb. per head per day. If these instructions are followed then cocoa by-products are most useful in the diet, as they are rich in fat protein and vitamin D.

2. Foods unsuitable for Long Storage

This category includes processed foods like fresh yeast, wet grains, and undried food waste. Materials of this kind must obviously be used up quickly and cannot therefore be subject to control. Their food value is inversely proportional to the moisture content, but all three commodities mentioned above would fill a useful place in the diet. Wet grains, a by-product from brewing and distilling, normally contain up to about 70 per cent moisture, but they are fairly rich in carbohydrates and contain some protein. A succulent food such as this is well relished by cattle; they may be fed comparatively large quantities—up to 40 lb. per day.

Wet yeast is a good high protein food, provided the proper precautions are observed in feeding. The ferments in wet yeast are still active, and if these are not killed fermentation is liable to occur in the alimentary tract, giving rise to serious digestive trouble. Fresh yeast should always be boiled before use and can best be used by drying off in a mash. About 10 per cent of wet yeast in a ration for pigs and poultry is an excellent protein and vitamin supplement.

Semi-dried food waste, or Tottenham pudding, is available near large urban areas. Its composition is variable but normally comprises vegetable waste, together with a certain amount of meat scrap, etc. It provides a useful fattening food,' particularly for pigs and poultry ; some samples are apt to be rather fatty, in which case the amount should be reduced. In all cases when making up the mash it is advisable to watch for the presence of extraneous materials such as wood and metal.

3. Food Supplements The third group of unrationed materials are those of which the accepted feeding standards would not be exceeded, however freely available they may be ; they are food supplements rather than feedingstuffs in the conventional sense of the word. Of these, minerals, cod liver oil and spices are the most important. In normal times minerals should preferably be incorporated into the compound ration, but in these days of scarcity the small proportion of the compound relative to the total ration may lead to some mineral deficiency. Should this be the case it may be a wise precaution for the stock-keeper to include a small additional amount of minerals in the food. For growing pigs and poultry, in particular, the ration of purchased compounds, although mineralized, may not be fed in sufficient amount to provide the necessary requirements for bone formation, etc., and a little extra bone flour and limestone flour may be an advantage.

Cod liver oil also is a useful supplementary food for young animals and for all stock reared in winter or under intensive conditions. Cod liver oil is added to all compounds for young stock and to winter layers' mash, but unfortunately vitamin A is not very stable and may be lost completely before the compound is actually used. The addition of ½ to 1 per cent of cod liver oil to the mash immediately prior to feeding would be a safe precaution, although, of course, it would need thorough mixing-in—preferably by rubbing it into one of the dry constituents.

The addition of spices to animal feedingstuffs is a debatable subject, of which the merits and de-merits need not be discussed here. Spices would, however, appear to have a useful function in rendering the more unpalatable foods more appetizing as, for instance, when food waste of out-of-condition materials are included in the diet.

4. Grass Meal Grass meal is sufficiently important to warrant an individual section. This material was never ationed, probably because of difficulties of control. By its very nature, grass meal has a most variable analysis ; its quality depends upon the type of herbage used, whether grass, clover, or lucerne, etc., upon methods of management and fertilizer application, climate and rainfall, and on the time and length of cut. Grass has maximum nutritive value when it is growing rapidly, and therefore dried grass produced in spring and following the autumn flush is higher in protein and carotene than at any other time of the Year. If the grass is allowed to mature before cutting it becomes more fibrous with lower carotene and protein content. As a rule, lucerne has rather more than protein dried grass, and it maintains this higher level more consistently throughout the season.

Dried grass, or any other form of dried green food, has a dual role in this country ; it may be used as a bulk food or as a carotene supplement. In the former case, it will be fed in relatively large amounts in the diet in place of purchased feedingstuffs, particularly for milk production. Good quality grass meal or dried baled grass would have a starch equivalent at least equal to that of oats, and the protein equivalent should be considerably higher. Material such as this could be fed at 4 lb. to the gallon with every success, especially as it would provide the vitamin A so necessary to maintain the winter health of the animal. Good quality dried grass may also be used fairly extensively in rations for growing and laying hens and for growing pigs. It is not suitable in large quantities for chicks, because of its fibrous and rather bulky nature ; nor for finishing pigs, because of its tendency to produce soft and yellow fat.

In many cases, however, grass meal is fed more as a carotene supplement to provide vitamin A in winter. The amount would then not normally exceed 5 per cent in the diet, and the protein content is therefore of comparatively little importance. The essential here is that carotene shall be as high as possible, and for winter use it is advisable to purchase late-cut grass that has had less opportunity to deteriorate during storage. Any animal, except possibly pigs in the last stages of fattening, will benefit from the addition of 5 per cent of good quality grass meal in the winter ration.

5. Materials of Dubious Feeding Value Unfortunately all too frequently on offer, these materials comprise by-products that would not normally be classed as feedingstuffs, and hence could not be controlled without implying that they have a feeding value. By their very nature the majority of these by-products are useless for feeding, and in pre-war times most of them were utilized as conditioners for fertilizers or were burnt on the factory fires. They cannot be condemned outright because some have a limited feeding value for cattle, but this certainly does not justify their widespread sale, especially to pig and poultry keepers. The majority of unrationed feedingstuffs examined at these laboratories comprise such by-products as coffee residues, fruit-stones, glume meal, oat husks, linseed chaff, and root ends. Materials of this type need very careful consideration before feeding. They are generally very high in fibre and consequently are totally unsuitable for young stock and for animals such as pigs and poultry which have simple digestive tracts. Cattle, on the other hand, have quite good capacity for dealing with fibre, and therefore linseed chaff or oat husks can be fed in place of part of the maintenance ration of straw. Linseed chaff, for instance, may contain some small seeds, and its oil content may be appreciable ; glume meal also may contain some of the undersown clovers and provide some protein. Materials such as these can therefore be accepted for cattle if it is recognized that their value is really only comparable with that of straw. Others, such as fruit-stones, may contain over 50 per cent of very lignified fibre and are quite useless, even for ruminants.

Seeds and screenings need feeding with discretion also. Linseed screenings are probably the most commonly available but their composition is extremely variable. Some contain a fair proportion of small seeds, so that their oil content may be high and protein quite fair ; others again, consisting mostly of flax shives and root ends, have questionable feeding value. Screenings from linseed or other seeds are apt to contain high proportions of sand—up to 20 per cent in the worst instances ; not only is the purchaser paying a high price for this sand but also it may cause serious trouble when

mixed into a mash. If screenings of this type are purchased they are best fed straight to poultry, which they can pick over.

Seaweed meal is frequently encountered as an unrationed food at present. The nutrients in seaweed are not comparable with those in cereals or oil cakes, and in particular the carbohydrates are not of the same feeding value as starch or sugars. Seaweed may have a certain feeding value for cattle, but it seems rather doubtful whether pigs or poultry can make much use of its nutrients. Seaweed is certainly a rich source of some trace elements such as iodine, manganese, etc., but the minerals as a whole are unbalanced and the high proportion of potash is not good for stock. Seaweed meal cannot therefore really be advocated as a desirable food in pig and poultry rations, though small amounts would not be harmful to cattle.

Many of the unrationed mixtures available at present are composed almost entirely of materials in this category. They usually consist of oat by-products, linseed screenings, glume meal, minerals, and perhaps some unrationed high protein constituent such as dried yeast. Mixtures of this sort are sold as rabbit foods and are not intended for feeding to other classes of stock. If they are fed to pigs or poultry nothing but harm can result, because the high fibre content leads to extremely poor digestibility and the amount of available energy they provide will probably be less than that required in digestion. When a stock-keeper requires unrationed foods for pigs or poultry he would be better advised to purchase and mix his own materials, unless he is satisfied that the mixture was approved by the Ministry for feeding to that particular class of stock. Even for cattle, the purchase of unrationed mixtures is not to be recommended, because price is not usually commensurate with feeding value.

6. Materials to be Avoided There are some so-called feedingstuffs on offer that were originally intended as fertilizers. The sale of these is bordering upon illegality because it is really a case of misrepresentation. Meat and fish residues condemned as unfit for feeding owing to serious decomposition or the presence of disease organisms are relegated to fertilizers. It is not uncommon to find fertilizer meat meal with as little as 20 per cent true protein, as against 45 or 50 per cent crude protein, the large difference being evidence of the amount of decomposition that has occurred. In many cases the scarcity of animal protein has led to such materials being resold as feedingstuffs—a practice that presents a very serious danger to the stock-keeper. If the material is badly decomposed it is very likely to harm the animals ; if diseased, as with anthrax, etc., it may lead to a serious outbreak ultimately necessitating slaughtering the stock concerned. The following example will stress this point : some years ago a sample of Argentine fertilizer meat and bone meal was received at these Laboratories, with a request to advise on its suitability for feeding. Naturally inquiries of this sort are rejected unequivocably, but in the course of the routine analysis anthrax was contracted by the operator.

Mustard cake is also offered occasionally, although this material is better used for fertilizers than for feeding. It contains the glucoside potassium myronate and is actively harmful to young stock in particular. Cattle might take a little mustard cake, but it is not a practice to be recommended.

Unrationed materials will remain with us until the feedingstuffs position improves sufficiently to allow the farmer a choice to satisfy his full requirements. The more inferior by-products will then quickly disappear and those of real value will find a sale on their own merits and at an economic price. Until then, purchasers would be well advised to look very closely into the nature of these foods and decide whether they are of any real benefit or whether they are merely supplying so much bulk.

UNRATIONED FEEDINGSTUFFS

The table below gives a rough guide as to the analyses of typical unrationed feedingstuffs, although it must be emphasized that some of the more variable materials may show considerable differences from the quoted figures.

Description	Moisture	Oil	Protein	Carbo-hydrate	Fibre	Ash	Remarks
Locust Bean Germ	10	3	45	32	5	5	Excellent for all stock.
Biscuit Meal	8	5	13	68	1	5	Suitable for all stock, particularly pigs and poultry, but requires sieving before use. Test for presence of self-raising powders.
Bakery Waste	10	3	10	70	2	5	
Flour Sweepings	15	2	12	64	3	4	
Dried Egg Powder	13	35	45	—	—	7	An excellent food for all stock at 2½ per cent.
Dried Yeast	10	1	48	35	—	6	Excellent for all types of stock.
Dried Blood	15	1	80	3	—	3	Rich protein supplement if of feeding quality.
Cocoa Shell	10	3	16	47	16	8	Good for adult cattle at 2 lb. per day. Dangerous for other stock.
Wet Yeast	(Analysis depends on moisture content, but protein constitutes approximately 50 per cent of the total solids.)						Needs boiling before use. Good source of protein and B vitamins.
Wet Grains	70	2	7	14	6	1	A succulent food for adult cattle.
Semi-dried Food Waste	70	3	5	17	2	3	Suitable in relatively large proportion for pigs and poultry.
Grass Meal							
Spring	8	4	18	46	16	8	Any dried green food rich in carotene provides vitamin A, for winter feeding particularly. As a bulk food, good grass can be fed at 4 lb./gal. of milk, and form about 20 per cent of adult pig and poultry food.
Mature	8	3	9	45	27	8	
Autumn	8	4	16	48	18	8	
Lucerne	8	4	18	41	20	9	
Coffee Residue	10	12	10	40	25	3	Not recommended.
Plum Stone Meal	14	3	3	23	50	7	Useless.
Glume Meal	15	1	4	40	32	8	Equals straw for cattle useless for pigs and poultry.
Oat Husks	7	1	2	54	32	4	
Linseed Chaff	12	3	6	32	40	7	
Linseed Screening	8	10	14	18	18	32	Good samples are satisfactory for cattle but possible high sand content is a danger.
Seaweed Meal	14	2	8	48	10	18	Of doubtful digestibility. Not recommended.
Fertilizer Fish Meal	15	8	60	2	—	15	Exceedingly dangerous owing to possibility of disease.
Fertilizer Meat and Bone Meal	13	15	40	—	—	32	
Mustard Cake	10	8	25	38	14	5	Dangerous for all stock.

CUMBRIAN DRAINER

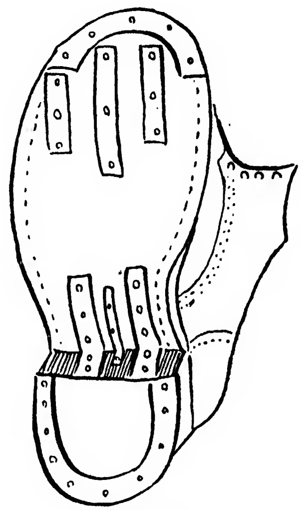
J. L. BRYSON

Penrith, Cumberland

Illustrated by the author

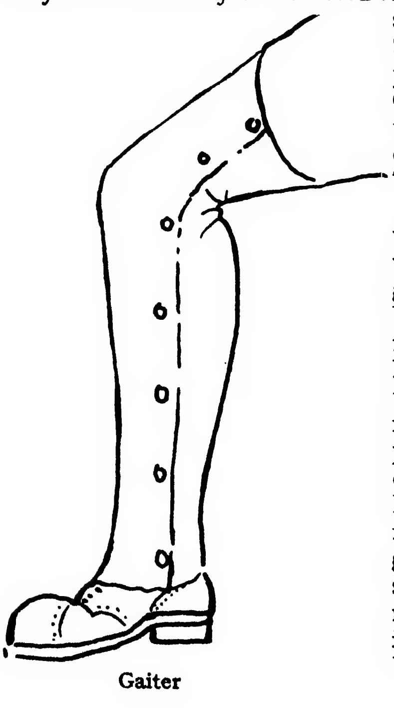
IT is a never-ending pleasure to watch an experienced drainer of the old school at work with his own, well-set tools, getting the most a man can out of a job being well done. He never cuts out a pound more than necessary ; he never puts his feet into the bottom of his drain ; he is too conscious of his smooth artistry to spoil it. Cutting drains is a back-breaking job, but the old-timer reduces the strain to a minimum.

Dress and Tools for the Job Let it be said at once that draining is a skilled job, and that there is no room for weaklings. The practised hand gets the maximum result with the minimum effort, but the beginner quickly learns that few jobs are more laborious. That is not to say that the work is monotonous ; it varies with the tools, and to a good workman a change is as good as a rest.



Plated boot

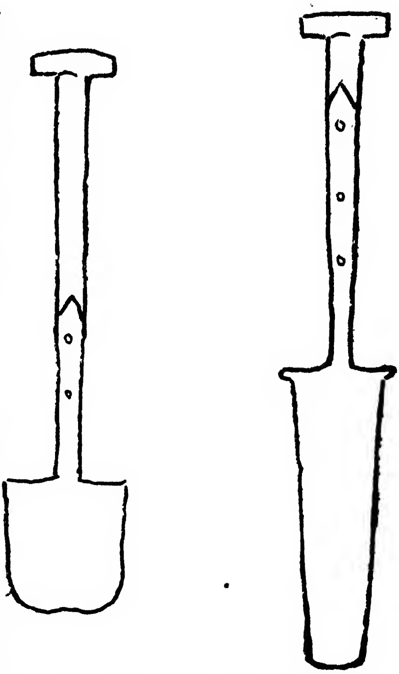
As regards dress, gum boots are useless ; drainers never work in bogs without first moving the surface water as they proceed. When using digging irons, gum boots are cumbersome, loose, soon absorb sweat, and so begin to smell and then rot. A good drainer puts his heel on the spade, and the toe or ball of his foot on the billy ; the billy is too narrowly constructed to have the iron successfully applied to it in a narrow drain. Strong boots or clogs shod with metal plates, as shown here, are essential. Corduroy gaiters buttoning at the side like the spatterdash worn by soldiers in the eighteenth century, cannot be bettered. They should reach above the knee.



Gaiter

As soon as a man has been on drainage work for a few months he should be supplied with a set of tools for his own use. A man gets the feel of a particular tool once he has broken it in, just as a soldier does for his rifle. If he shows skill at bottoming keep him at first on that particular job, but see that he has the tools to do *every* job. These, in order of use, are dyking spade (with pointed blade), crumbing shovel, billy or draining tool, swan-neck and pick. Mattocks may be necessary to deal with roots but they need not be included in a general issue. Two or three dyking spades can be sharpened and the blade rounded as turf nickers or cutters. There is no use in a draining field for square-bladed spades or navvy shovels. In a gang

a swan-neck for crumbing up and shaping the bottom of a drain larger than a 3-inch tile could be issued, but it is not essential to a good drainer. Tiles should be set by hand by a man in the bottom so that they can be pressed into place. In a good cut that is the only time when it is necessary to disturb or get into the completed drain. Tile-setters are not very satisfactory; a pipe set by hand can be made firm and packed into place by touch; a pipe well set by hand will not budge.



Left. Worn dyking spade sharpened for use as turf-cutter or nicker.

Right. Billy, or draining tool, well plated for extra strength.

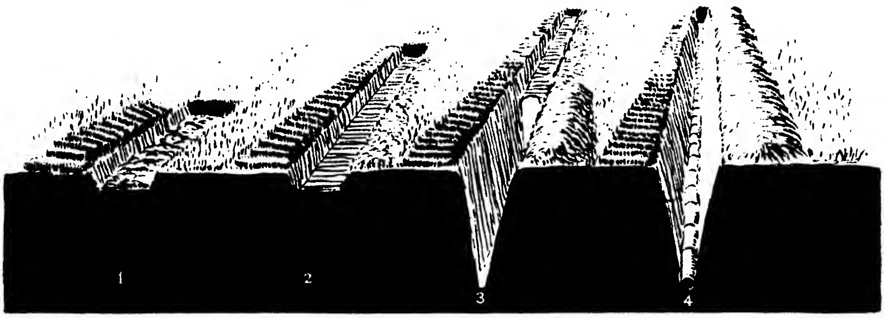
Cutting a Drain When nicking or cutting the turf along a guide line, the sod should be eased up with each cut. This breaks the roots and facilitates removal. The turf can then be sliced in large sections and lifted clean. A man tearing and pulling at a badly nicked sod soon tires. The sides of the drain are then cut again and eased as in turf cutting. The loosened crumbs are lifted out with the long-handled crumbing shovel, using the thigh to push the shovel forward and the knee to raise it and deposit the soil dead on the beam of the drain. The spoil is never thrown out or scattered; it is neatly piled to ease back-filling. If the drain is to be shallower than 2 feet 6 inches a spade's depth and breadth can be cut out after the sod is removed. This leaves a final narrow cut to be made with the billy. Down to 1 foot 8 inches the billy can complete the cut right after the sod and ensuing crumbs are removed. The billy is thrust down almost to its full length at either side then the forward cut lifts it out compact and clean. The bottomer cuts for about 4 feet, then crumbs up and shapes the bottom ready for the tile. I am speaking of good clay, with 12 inches of soil on top of it. The above applies to all soft, easy cutting.

If the drain required is to be deeper than 2 feet 6 inches a double cut with the billy is needed. This is done by cutting at an angle first down one side then down the other, so that a loose end is always left to ease off; then one side cut, followed by the forward cut, serves to lift out each side. The turf is placed on one side and the spoil on the other.

The only time a drainer needs to get into the bottom is to set the tile. He should work backwards from the main and tap in all other old drains that have been severed. All tappings should be made as sediment-proof as possible with broken tiles, flat stones and grass. Blind* the tiles with a few inches of soil (about four) then throw the sods in, taking care not to smash a tile. Back-filling is hard work and is best done with boards fixed on a cultivator or with a small scraper attached to the front of a tractor.

* i.e., to embed and cover over.

Trouble with Old Drains If old choked drains are deep, one or two drains can be cut diagonally through them at strategic points to catch their water and get an inch below them and tap



1. **Turf eased and sod removed.**
2. **Sides cut, eased and crumbed.**
3. **First billy cut, showing spoil neatly piled**
4. **Tiles set snugly in swan-neck shaped bottom.**

in every one carefully. This may be all that is necessary to dry a field. If there is an obvious fault of clay with a gravel bar, it should be broken deep down. The reason one field is wet and another dry does not mean that one is drained and the other is not. It indicates that the underlying strata are different ; one is faulty, holds and spills water, the other is uniform and can dispose of its surface water naturally. Old drains cause more trouble than is generally realized ; they must be tapped at their own level. If an outlet is shallow it should not be drained until it is cleared and deepened ; for example, it may be necessary to deepen a mile or more of ditch before a field can be properly drained. It is of no use merely to tinker with it.

Drainage water on a slope has tremendous pressure. If blocked an old inch tile and collar can do an immense amount of harm, and they are often at a depth of 4 feet. They should be tapped where the pressure is strongest and then again above that point.

MILKING MACHINE MANAGEMENT
SOMERSET COMPETITION

K. D. Maddever, N.D.D. and J. W. Egdell, B.Sc.
National Agricultural Advisory Service

MACHINE milking is rapidly replacing hand milking on our dairy farms; and the speed of this transformation is governed only by the rate at which the machines can be made. Undoubtedly the mechanization of milking will continue to increase in face of the scarcity of skilled labour for hand milking. That being so, and bearing in mind the urgent need for an increased supply of milk of satisfactory quality—chemical quality as well as keeping quality—it is important that milking machines should be handled both skilfully and intelligently. This calls for sound knowledge of cow management—particularly in regard to let-down and the extraction of milk, as well as of the machine mechanism. It is also necessary to appreciate the importance of cleaning and sterilizing the machine properly.

With these ends in view, a milking machine management competition was held in Somerset from January to April, 1948. Separate classes within the competition were provided for milking parlours, bucket plants, and skid-bails. So great was the response of producers wishing to take part, that the number of competitors had to be limited. In all, there were 117 competitors, the numbers in each of the classes quoted above being 45, 57, and 15, respectively. In the milking parlour class the average size of the herd was 40 cows, in those for bucket and skid-bail milking, 30 cows.

Every competitor was visited once each month and the milking operation judged, special attention being paid to efficiency and speed of milking. Marks were awarded, the maximum being 50. Visits were also made each month to assess the efficiency of washing and sterilizing the machine by rinsing it with sterile water and subsequently examining the water bacteriologically under the direction of the N.A.A.S. Provincial Bacteriologist. With bucket plants, one milking unit and bucket were rinsed; with bails and parlour-type plants, the sterile rinsing water was passed through one unit and the pipe-line system. The volume of rinsing water was varied according to the size of the milking plant, so that the volume per unit area of machine surface rinsed was the same for all competitors. The samples were examined for bacterial count, coliform organisms, and thermoduric (relatively heat-resistant) bacteria. In addition, tests were made for the presence of milk-souring bacteria, and when the thermoduric bacteria were abundant they were isolated and identified for advisory purposes. A maximum of 50 marks per sample was awarded for bacteriological cleanliness.

Time and motion studies were made on each farm, and after each round of visits competitors were informed of the marks obtained. Constructive criticism and advice was given to correct weaknesses in the management of the machine. At the end of the competition, first-class certificates were awarded to machine operators obtaining 85 per cent of the possible marks, and second-class certificates awarded to those with 65 per cent.

Results Analysed Of the total number of farms in the competition, 65 per cent used "hot-water" for washing the cow's udders, the majority having started this system after seeing the Petersen film *Science of Milk Production*. In 50 per cent of the herds "back cords" were used; this increased the average time taken to milk each cow, and the general conclusion is that in many instances "back cords" are not really necessary. One-third of the competitors regularly dipped the teat-cups in an approved sodium hypochlorite solution after milking each cow, to

minimize the risk of spreading mastitis. The majority adopting this practice were parlour-milking.

In nearly half the herds hand stripping had been given up. In the hand-stripped herds the time taken to milk the cows was greater than with those stripped by machine.

On the average, milking was quickest in the parlour and slowest in the skid-bail, but the more carefully constructed collection pens in the skid-bails helped to reduce the time taken to get the cows into the bail; also it was observed that more cows can be milked by one man in one hour in a parlour than in a bucket plant or skid-bail. With the increase in the number of milking units handled by one worker, the average time taken to milk each cow is increased, but the total number of cows milked per man per hour is greater. Two units per worker appears to be the optimum; if too many units per worker are used there will be no saving in time.

The proportion of herds officially milk recorded in the parlour, bucket plant and skid-bail classes was 80 per cent, 70 per cent, and 40 per cent, respectively. The percentage in the bucket-plant class was high, in view of the inconvenience of recording when using this type of plant.

The general results of the sterile rinsing water samples from the machines were very encouraging. Although it was evident that the cleansing and sterilizing were not being carried out efficiently on some farms, in the main it appeared that a genuine attempt was being made to reach and maintain a satisfactory standard. All competitors adopted steam sterilization after the morning milking, but only very few used steam after the evening milking, although some used hot water and/or approved hypochlorite as an alternative. Eighty per cent of the dairies used a detergent in the washing water.

Nine competitors (8 per cent) did not lose a single mark on the bacteriological examination of samples, while 61 per cent obtained at least 80 per cent of the possible marks, and 82 per cent obtained 66 per cent.

When the bacterial counts were considered in terms of bacterial contamination per sq. foot of plant surface, it was found that 69 per cent of the samples fell within the satisfactory standard of not more than 5,000 per sq. foot, while another 10 per cent, with not more than 25,000 organisms per sq. foot, were regarded as fairly satisfactory.

The presence of large numbers of thermoduric bacteria on dairy plant surfaces signifies that cleansing and sterilizing have been inadequate for a considerable time, during which these bacteria have accumulated. Where, however, the daily treatment of the plant is thorough, the numbers of thermoduric bacteria are always negligible. Of the total samples examined, 55 per cent were regarded as satisfactory and 20 per cent fairly satisfactory in respect of thermoduric bacteria. Only 3 per cent of the samples contained coliform organisms, and 72 per cent were free from bacteria capable of souring milk.

It was most gratifying that the general standard of efficiency, both in respect of the milking operation and the cleansing and sterilizing of the machine, improved steadily as the competition progressed. From the bacteriological aspect, a measure of the improvement achieved can be gauged from the fact that the proportion of samples submitted during the first month with a total bacterial count and a thermoduric organisms count of 1,000 or less per sq. foot of plant surface was 30 per cent and 40 per cent respectively, whereas the corresponding proportions for the final round of samples—when the weather was much warmer—were 70 per cent and 71 per cent respectively.

The marked improvement in general efficiency of machine management reflects the educational value of the competition and the practical interest shown by the competitors and their dairy workers generally.

GRASSLAND ON A NORTHERN IRELAND FARM

ROBERT BELL, B. Agr. and KENNETH A. MCDOWELL, B. Agr.
Ministry of Agriculture, Northern Ireland

CONSIDERING the large increase in the tillage acreage in Northern Ireland since the beginning of the war, and the concurrent diminution in supplies of feedingstuffs, it seems logical to conclude that the number of livestock would have decreased. In actual fact during the period 1939 to 1945 the number of dairy cows and in-calf heifers increased by about 30 per cent and the number of cattle fattened rose by about 70 per cent. Even allowing for the fact that the number of lowland sheep decreased, and that some of the cattle are fattened indoors in winter, there is no doubt that the output per acre from the reduced area under grass is much greater than before the war.

It is interesting to note that in the best arable districts of the country, where the tillage area has been greatest, the increase in the livestock population has also been greatest. This suggests that the present system of short-term leys necessitated by the large area under the plough in these districts gives a greater output per acre than was previously obtained from the more permanent types of grassland.

At the British Grassland Society meeting held in Northern Ireland.this summer, members were shown leys on Mr. Frank Thompson's farm at Eglinton, Co. Londonderry. These leys were considered by many to be as good as could be found anywhere.

Six-Course Rotation Mr. Thompson's farm consists of 370 acres, of which 270 acres are arable. In addition some 80 acres are rented each year. Even in pre-war days a large area was cultivated. Then, as now, the main cash crop was early potatoes, but there was also a heavy cropping of oats, beans and swedes for the winter feeding of fattening and store cattle.

The soil on a large part of the farm is a good medium loam overlying a well-drained, gravelly subsoil, and so is ideal for early potatoes. On the best of the potato land this crop, although rarely grown for two consecutive years in the same field, may be taken several times in the rotation before sowing the field down to grass. The first crop in the rotation is always potatoes, since the land is much too fertile to give a successful crop of ley oats. Immediately after the early potato crop is lifted in June or July, the land is either sown with Italian ryegrass for the production of seed, or catch cropped with turnips or marrowstem kale and Italian ryegrass. This system forms the basis of the farming programme, and a typical rotation would be :

Potatoes (after ley)—Italian ryegrass—oats—potatoes—oats—grazing ley (kept down for three years or longer).

Immediately after digging the second potato crop, the land is either sown down directly to grass, or oats are undersown in the following spring. Mr. Thompson's special reason for this is that he cannot get a good strike of clover after swedes or turnips.

Each potato crop, except that taken after ley, is dressed with farmyard manure at the rate of 20 tons per acre. In addition a dressing of 12 cwt. per acre of fertilizers is applied. The high level of fertility maintained as a result of this liberal manuring is reflected in the high yields of early potatoes and ryegrass seed that can be obtained, and in the high quality of the ensuing pasture.

The crops grown in 1948 were 50 acres early potatoes, 84 acres oats,

10 acres beans, and 32 acres swedes. No Italian ryegrass was grown for seed, owing to the recent price reduction.

Fattening Cattle and Stores Apart from about 250 lambs bought in the autumn, fattened on Italian ryegrass and marrowstem kale and the rotation pastures, and disposed of from January to March, the only stock kept on the rotation pastures are fattening and store cattle. All the cattle are bought in when they are two to three years old: about 300 cattle are bought and fattened annually. Normally from 80 to 90 forward stores are purchased in October each year and housed in open sheds. They are fed on a ration of crushed oats, beans, swedes, turnips or marrowstem kale and straw, and disposed of in from 2 to 3 months after purchase. Owing to the large amount of fodder trampled down by the fattening animals, this farmer considers it much more economical to feed straw than hay, and he saves no hay; neither does he conserve any grass.

As opportunities present themselves, and as house-room becomes available throughout the winter, more store cattle are bought in with the object of having 150 ready for spring and summer grazing. The stock can usually be let out to grass during the day from February and kept on grass continuously from March onwards. They are usually ready for disposal in June and July, when a further lot of about 50 is bought and made ready for sale in the autumn.

As far as the profit from the fattening cattle is concerned, it may be said that it comes mainly from summer fattening. This, therefore, is the reason why Mr. Thompson makes every effort to maintain the stock-carrying capacity of his grassland at the highest possible level.

There is a total of some 80 acres of young leys on the farm. As previously mentioned these young leys are sown down after the land has been subjected to an intensive course of arable farming, during which fertility is maintained at the highest level. The great productivity of the leys is due, in no small measure, to the liberal manuring given to the preceding potato crops.

First-class Grass gives Intensive Stocking Before reseeding, the ground is prepared by thorough and suitable cultivations. A minimum dressing of 60 cwt. per acre of burnt lime is always applied before the seeds are sown. Good seeds mixtures are always used, the type and blend of the mixtures being widely varied according to the type of soil, and the length and purpose of the ley.

Examples of seeds mixtures used are:

(1)	*lb.*	(2)	*lb.*
Irish commercial Italian ryegrass	4	Italian ryegrass	10
Irish commercial perennial ryegrass	14	Danish cocksfoot	5
Akaroa cocksfoot	10	S.26 cocksfoot	5
Rough-stalked meadow grass	1	S.143 cocksfoot	5
Crested dog's tail	1	Crested dog's tail	1
Late-flowering red clover	2	Rough-stalked meadow grass	1
English uncertified white clover	2	S.123 red clover	2
Kentish wild white clover	1	S.100 white clover	1
		New Zealand white clover	1

As cocksfoot has been found to give excellent results on all but the heavier soils, a high proportion of it is included in the seeds mixture where the land is suitable. It is particularly valuable for heavy grazing in August, when the ryegrasses fall away in production.

The inclusion of Italian ryegrass in the mixture pays handsome dividends on this farm. In one of the fields where more than the average rate of

seeding of this species was sown, the sward was dominantly Italian ryegrass in its fourth grazing year. It may seem strange to include crested dog's tail in a mixture for this type of land, but Mr. Thompson is convinced that its winter growth gives the cattle an early bite and prevents the land from poaching when the cattle are let out for short periods daily early in the year. For these reasons the inclusion of this, reputedly inferior, species appears justified.

Hay is not taken from the young seeds, and this has a twofold advantage. First, it leaves a greater area of pasture for summer grazing and, secondly, it permits the young swards to be grazed right from the start—a form of management which is invaluable in the establishment of a first-class sward.

Every spring all the young leys are given a dressing of 5 cwt. superphosphate and 1 cwt. muriate of potash per acre. No nitrogenous fertilizer is applied, except occasionally in the autumn if thought necessary to increase the amount of back-end keep. Under the conditions on this farm the application of sulphate of ammonia in the autumn has no effect on the ratio of grass to clovers the following year.

When attempting to list the factors which have contributed to the making of the excellent pastures on this farm, account must be taken of the grazing management, as well as the effects of suitable seeds mixtures, of high fertility, and of grazing right from the start. The basis of the grazing management is a high concentration of stock on a particular field until the grass is eaten down, after which the stock are moved to a fresh pasture and the grazed field rested until the sward has fully recovered.

It is regretted that production figures for a full grazing season are not available. There are, however, official figures for a part of two grazing seasons, and they are recorded here so that some idea of the high productivity of the leys may be gained.

In 1946 an area consisting of three fields totalling 23 acres was grazed with bullocks from March 14 until September 11. The liveweight increase of stock grazing on this area was 95 cwt., or more than 4 cwt. of liveweight increase per acre. This trial covered only a part of the grazing season, and as the grass was still good when the cattle were sold fat, the area was restocked with forward stores for the remainder of the season and with sheep until February.

This year a field of 19¼ acres has been grazed with heavy bullocks and a record of stock grazing kept. From mid-February until August 19 the number of stock-grazing days per acre recorded was 246. There is still a lot of grass on the field (August) and intensive grazing continues. Regarding the stock-grazing days it should be noted that 30 cattle were housed for 25 nights during February and March.

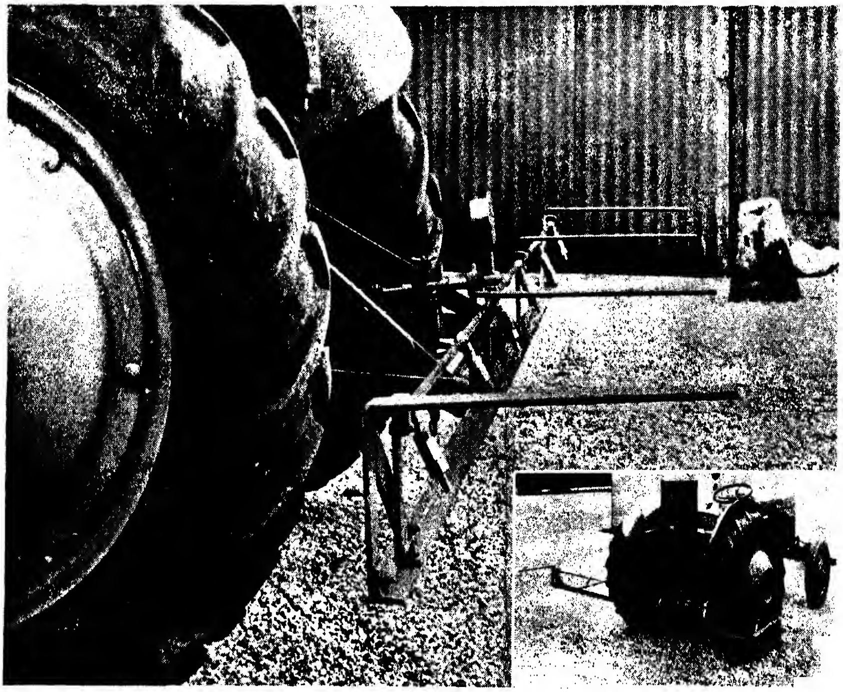
The total area under permanent pasture is 50–60 acres, much of which has not been under the plough for at least thirty years. The main reason why this area is not ploughed and farmed according to the system already described is that most of the soil is a heavy clay not suited to the growing of early potatoes. Excellent fattening permanent pastures are, however, maintained by systematic management and manuring. Rotational grazing, with suitable rest periods, is practised with marked advantages.

Rejuvenation of permanent pasture without ploughing has also been practised with beneficial results. The grazing is well torn with a grass harrow early in spring, and 5 cwt. superphosphate and 2 cwt. muriate of potash are applied per acre. A seeds mixture consisting of 10 lb. commercial perennial, 3 lb. Kentish indigenous perennial, 3 lb. cocksfoot, 3 lb. timothy and 1 lb. Kentish wild white clover is sown, harrowed and rolled in.

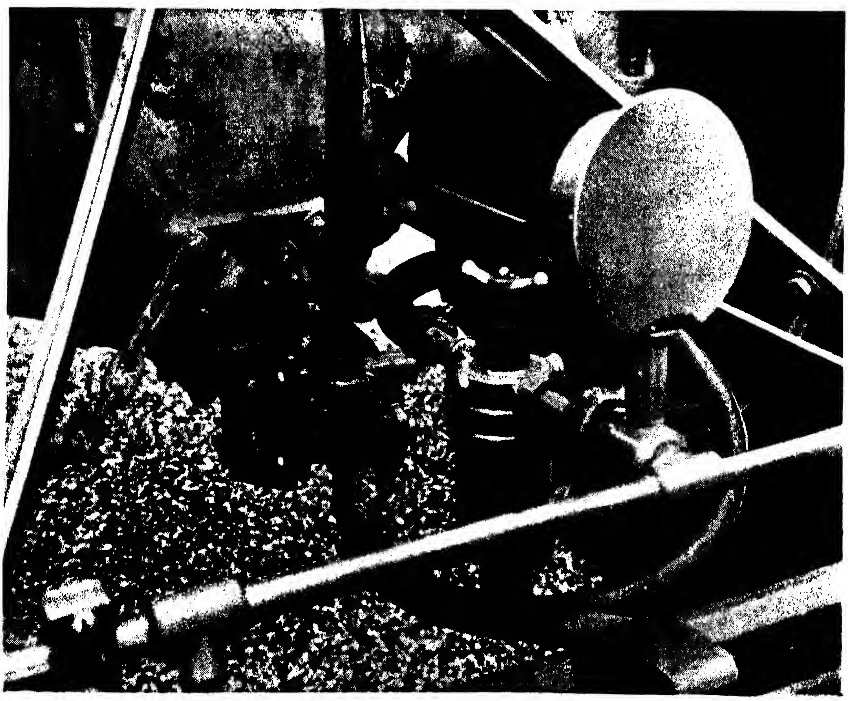
Grade "A", T.T. Ayrshire herd at Ballymoney, Co. Antrim.

Photos.: *British Cou*

Fattening bullocks at Aghalee, Co. Antrim.

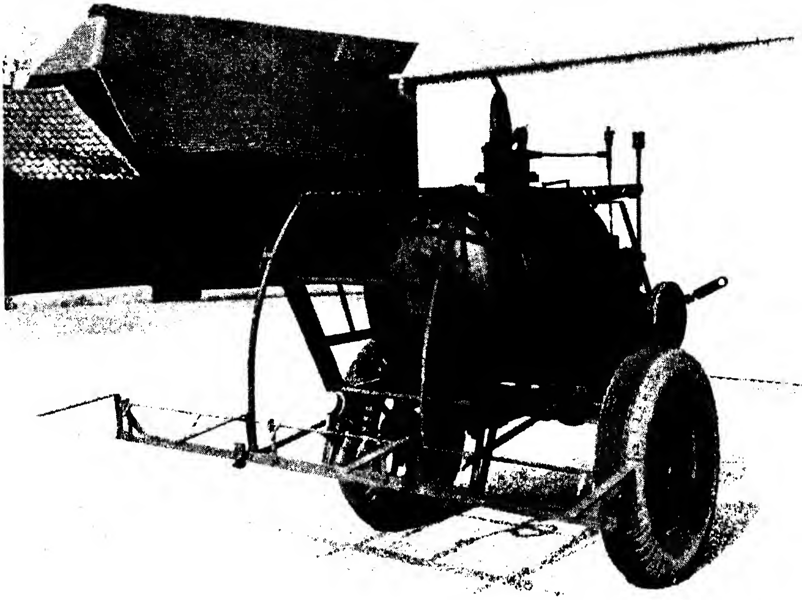


Ferguson tractor adapted as low volume sprayer, showing nozzles, pressure gauge, and main filter.

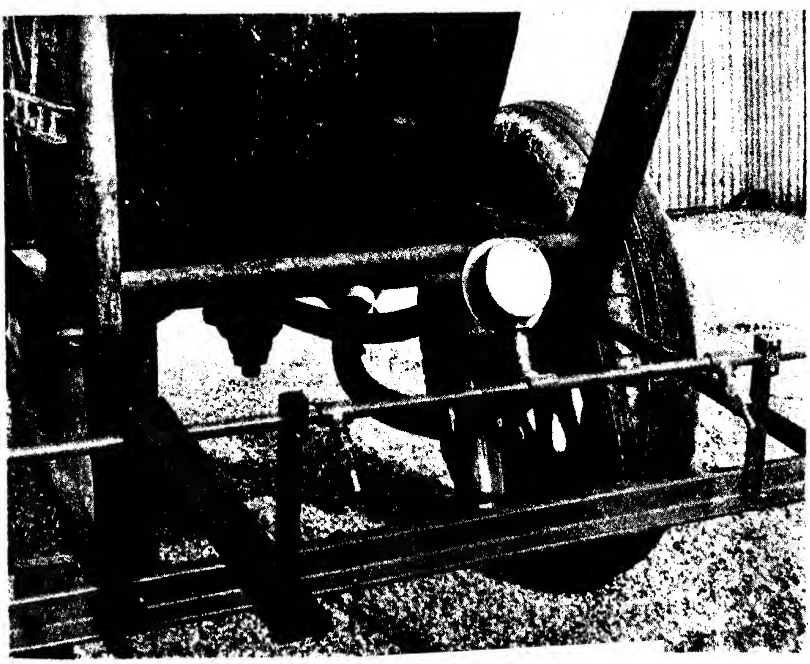


2. Close-up of gear pump, pressure gauge, and main filter.

WEED CONTROL (see pp. 441-3)



3. Barclay, Ross and Hutchison standard sprayer adapted as low volume sprayer.



Photos.: *Jealott's Hill Research Station.*

4. Close-up of the spraying boom.

TWO METHODS OF DE-HORNING CALVES (see pp. 444-6).

1. By chemical agent.

2. By electrical cauterizer.

ELECTRICAL PRE-WARMING OF TOMATO HOUSE SOIL (see pp. 447-50)

Soil-warming wires 15 inches deep.

Photos.: *F.K.*

Portable transformer.

Mr. Thompson has also ploughed up and directly reseeded some 26 acres of permanent pasture in 1947. The following seeds mixture was used :

	lb.		lb.
Devon Eaver ryegrass	8	Rough-stalked meadow grass	1
New Zealand ryegrass	22	S.100 white clover	1
S.143 cocksfoot	6	Kentish wild white clover	1

The reseeded area was well manured and rotationally grazed and is giving excellent results.

Some idea of the quality of the grass and cattle on this farm may be gained when it is considered that of all the fat cattle sold off the grass this season 80 per cent qualified for "super-special," 17½ per cent for "special," and 2½ per cent for "A+" grade.

LOW VOLUME SPRAYERS FOR WEED CONTROL

W. G. Templeman, M.Sc., Ph.D.
Jealott's Hill Research Station

SELECTIVE weedkillers and some pest control products are usually applied in about 100 gallons of liquid per acre. Because of the obvious saving in water and labour requirements, efforts have been made to use more concentrated solutions, emulsions and suspensions for various weed and pest control purposes. In addition to these obvious advantages it has also been claimed for low volume spraying that a greater proportion of solution remains on the leaves than if large volumes are used. Suitable machines capable of applying concentrated products and available at the present time are expensive, though excellent results are achieved.

Low volume spraying (e.g., 4-6 gallons of liquid per acre) of the growth-regulator type of herbicide has been simply and cheaply achieved in the U.S.A. and Canada within the last two years by spraying through nozzles similar to those used for air-humidification, giving flat, fan-shaped, finely divided sprays. Such nozzles have been used to replace the standard high volume nozzles on farm spraying machines of a wide variety of types and have also led to the development of tractor-adapted sprayers of a light and inexpensive kind. North American use of this method in 1948 was on a very extensive scale and was very effective.

Experiments at Jealott's Hill during 1947 indicated that low volume spraying of 2-methyl-4-chloro-phenoxyacetic acid (MCPA)* for weed control under British conditions was very promising. Accordingly further trials were undertaken in 1948, and this article describes the type of equipment used. This can only be regarded as a prototype in character and progressive modifications will be made. It was felt that the adoption of this very useful spraying technique in British agriculture would be most readily achieved by the publication of the limited preliminary information available at present.

Two types of sprayer have been used : (1) a standard Barclay, Ross and Hutchison farm sprayer was converted for low-volume work ; and (2) a Ferguson tractor was adapted as a low volume sprayer. The nozzles and filters used were common to both types.

*** MCPA is also known as "Methoxone" and is the active constituent of "Agroxone".**

Spray Nozzles Imported American nozzles of the appropriate type were used in the earliest trial, but during the search for a suitable British equivalent Mr. B. J. R. Evans suggested that Bray gas jets should be tested as spray nozzles. At about the same time it was learned from Mr. R. P. Fraser and Mr. M. O. Coulter that Bray jets were very useful for the application of insecticides.

These jets have a ceramic tip, with a moulded orifice mounted in a brass threaded holder; the orifice is accurately made and resistant to abrasion and chemicals. They are cheap and readily available in a variety of sizes. The spray issues in a flat fan-shape and distribution of spray across the fan is even. The following table shows the approximate discharge rates of three suitable jets operated at 30 lb. per square inch pressure:

Bray Jet Type	Gallons of Water Per Hour	Gallons Per Acre at 4 m.p.h.	
		Spaced 12 inches apart	Spaced 18 inches apart
Geyser one-hole Gas 000 ..	4.5	9.5	6.3
Geyser one-hole Gas 00 ..	8.6	18.1	12.0
"Neto" Acetylene No. 391 ..	2.1	4.4	3.0

For field use these jets were mounted in holders on a boom. The holder into which the jet was screwed, also housed a 200-mesh filter and a spring-loaded bronze ball to act as an anti-drip device (see Figs. 1, 3, and 4, pp. ii-iii of art inset). It is believed, however, that the individual filters may be unnecessary if a good quality efficient master filter is included at the boom inlet. A simple holder carrying the anti-drip device and the jet is all that might be required.

The rate of application of spray can be varied by choice of jet, by adjusting the spacing of the jets on the boom and the speed of driving.

Spray Boom and Filter The 6-foot boom consisted of ½-inch copper tubing held in position on 1¼-inch angle iron. Appropriate supports, also of angle iron, were provided so that a simple drag-sheet of hessian could be fixed to prevent drift. The nozzles were spaced at 12-inch intervals on the boom and set to spray at 45 degrees to the vertical. They were 18-20 inches vertically above ground level. The spray boom also carried a pressure gauge visible to the operator. An "Autoklean" filter of 150-mesh was fitted to the boom inlet (Figs. 1 and 2).

Conversion of Standard Farm Sprayer and Tractor Adaptation The Barclay, Ross and Hutchison standard sprayer was converted by removing the standard boom and replacing it by the boom and nozzles described above (Figs. 3 and 4). The pressure on the tank was adjusted to 30 lb. per square inch.

A Ferguson tractor was adapted to carry a container mounted behind the driver's seat, a phosphor bronze gear pump driven directly from the power take-off, and the boom and filter described above (Figs. 1 and 2). The container used was a 10-gallon drum fitted with ⅜-inch tube from the bottom fitted with a cock. The tube protruded inside the drum to prevent any sediment passing to the gear pump. A 40-gallon or larger container would be more suitable. The container support for the 10-gallon drum was made

of angle iron and was shaped to fit the differential casing of the tractor and secured by a single pin. Larger containers might demand stronger support.

An Albany ⅜-inch pattern rotary pump was mounted on a tubular bracket bolted directly on to the take-off housing, using the existing bolts. The size of gear pump used must, of course, be suited to the discharge rate required. Pump shaft and power take-off were connected by a female spline (Fig. 3). This unit was compact and efficient.

The container was connected to the gear pump by ½-inch rubber hose. A similar connection was made from the pump to the filter and boom.

Other tractors should also be readily adaptable as sprayers in a similar way.

Precautions The chief difficulty experienced in the earliest trials was nozzle blockage, and to reduce this to a minimum it was essential to maintain the equipment in a clean and well-washed condition, to ensure that the water and solutions used were clear and to make certain that the filter functioned well. Water and chemicals should be filtered as they are poured into the container. This may be achieved by using butter muslin or perhaps more satisfactorily by using a large 200-mesh filter in the filler inlet. From these considerations it seems unlikely that the equipment can be used for suspensions.

The rate of application of the solution is dependent on the maintenance of correct pressure and on the speed of working. In our trials a speed of 4 m.p.h. was used and the equipment was adjusted to give an operating pressure of 30 lb. per square inch at this speed. It would be an advantage if the tractor used for this type of spraying were fitted with a speedometer.

A drag-sheet was necessary under most conditions, and a simple one made of hessian entirely prevented drift.

Results The two types of sprayer described above were used on a farm scale to spray approximately 70 acres during 1948 with suitable diluted MCPA at 5-7 gallons per acre. Some of this area was infested with yellow charlock and white charlock in cereals, and some by creeping thistle in grassland. In all cases distribution was good, charlock was eradicated and a good top-kill of thistles obtained.

The details given in this article can serve as a basis for the construction of low volume sprayers. It is a reasonably cheap proposition to convert a standard farm sprayer or to construct a sprayer on a tractor with a power take-off. The right length of boom, size of container, the most suitable makes and types of components, the best fitments for various spraying machines and tractors and other details remain to be decided. Uses other than for the growth-regulator type of weedkiller may also be found.

Mr. R. L. Burgess carried out the trials and Mr. H. Dowden was responsible for the engineering work described.

TWO METHODS OF DEHORNING CALVES

R. Henson, N.D.D.
Boot's Pure Drug Co. Ltd.
Veterinary Science Division, Research Department, Thurgarton, Notts

THE growing practice of yarding cattle, especially dairy animals, is directing attention more and more to the advantages of dehorned stock. More such cattle can be kept in each yard, they can be handled with less risk of personal injury, and the food is shared more economically. With fattening stock there is no risk of the scars and bruises so often seen in the carcasses of horned animals. Bullying is not unknown amongst hornless cattle, but usually with the loss of their horns, horned breeds lose their fighting instinct. They can be driven through gateways without fear of that glancing blow which will rip a cow's udder and leave the way open for mastitis.

It is argued against dehorning that it is unnatural and that it spoils the appearance of our animals. Many farm practices now accepted as routine are also unnatural: lambs are docked, and male animals not wanted for breeding are castrated for good and sufficient reasons. The presence or absence of horns should not be allowed to distract attention from the points that really matter—milk or beef—neither of which has anything to do with an animal's horns. One may become accustomed to the appearance of hornless stock. Angus and Red Poll fanciers would not think their cattle improved if horns were grafted on. It is not their horns that give the Ayrshires a high place in the dairy world; it is their udders and their ability to produce milk. American and Canadian practice is more and more tending towards dehorning all cows.

The dehorning of older cattle requires the services of a veterinary surgeon; because of the pain involved it is done under an anaesthetic. Inevitably the animal suffers from shock, with at least some temporary loss in production, and there is always the danger of bacterial infection of the frontal sinus. The best time to dehorn, therefore, is before the horns have begun to grow, that is, in the first week or two of the calf's life. For some time it has been felt that the old methods of dehorning are not as satisfactory as they might be. Caustic soda or potash sticks have many disadvantages. They need very careful handling and it is easy to use too much and so cause excessive burning—even damage to the calf's eyes by drainage from the treated site.

Guthrie (1947), after preliminary tests with various dehorning agents, found that a flexible collodion solution of antimony trichloride gave the most satisfactory results. He claimed that this material was easy to apply and that the solution dried quickly into a firmly adhering flexible film which destroyed the underlying tissue with much less pain than the alkaline dehorning agent. He also maintained that there was no "weeping" of fluid to endanger the eyes. The formula recommended by him was:

	per cent
Antimony trichloride	28
Salicylic acid	7
Flexible collodion	65

Another method of dehorning calves is by cautery. Rowe (1947) was reported to have adapted an electrical soldering iron to form an efficient cauterizer, and this had obvious advantages over a fire-heated iron. The solid metal end of the iron was hollowed out to form a ring $\frac{1}{8}$ inch thick $\frac{5}{16}$ inch deep, and with an internal diameter of $\frac{1}{2}$ inch. The iron, heated by electricity, was held over the developing horn bud to sear a complete ring of tissue around it and thus prevent growth.

TWO METHODS OF DEHORNING CALVES

A test of these two methods has been made. The primary objects were to discover:

(1) The amount of irritation;
(2) The relative efficiency of the two methods;
(3) The most suitable age for the operation.

By Chemical Agent Twelve Dairy Shorthorn, Ayrshire and cross-bred calves of ages varying from 2 days to 5 weeks were treated. The hair was first clipped away from the horn bud and the area cleansed by a swab dipped in spirit. The preparation was then applied, care being taken not to touch the surrounding skin. The area covered was roughly the size of sixpence. As the solution will corrode metal, a wooden-handled brush, such as is used for glue, was found to be the best method of application. The solution dried very quickly to form a skin over the area. The method is illustrated in Fig. 1 (art inset p. iv).

One calf, No. 7 (see Table 1), was clipped but not cleansed before applying the agent. This calf showed signs of irritation and a tendency to rub the affected area against the rails of the pen. There was slight growth of one horn. The younger the calves when treated the less was the irritation. With the exception of No. 7, those dehorned at ages up to 10 days showed little sign of discomfort. Older calves showed signs of pain, especially Nos. 1 and 2. These calves had well-established horn growth, and much more of the solution had to be used on them than on the younger calves. There was no pain whatsoever at the time of application.

Table 1 shows the results of the treatment of the twelve calves. With those noted as showing strong horn growth, there is no sign of checking at all. Those marked "slight growth" have a thickening or swelling at the site of the horn which, however, has shown very little growth in three months. Those indicated as having no growth show no signs of horns; the hair has grown over the area and to all appearance they might have been born naturally polled.

Table 1. Calves Treated with Chemical Agent

Calf No.	Breed	Age when Treated	Age when Last Observed	Visible Horn Growth		Remarks
		days	*weeks*	*Right*	*Left*	
12	Ayrshire	2	12	None	None	
6	Shorthorn	4	16	,,	,,	
7	Ayrshire	6	15	Slight	Slight	Horn buds not cleansed
9	Shorthorn	7	14	None	None	
5	,,	8	12	,,	,,	
8	,,	9	14	,,	,,	
4	Ayrshire	10	18	Slight	,,	
11	Shorthorn	11	18	None	Slight	
10	,,	13	18	Strong	None	
3	Ayrshire	18	11	,,	Strong	
1	Cross-bred	28	20	,,	,,	
2	,,	35	20	,,	,,	

Age The amount of horn growth at a particular age varies with the breed and with individual animals. Some calves will have no more horn growth at 14 days than others at 2 days. Nevertheless, the best time of treatment to obtain consistent results would seem to be within the first week, preferably the day after calving. The horn bud can then just be seen and can be destroyed with a minimum of solution. The older the calf the more likely it is to rub, as there is more tissue to burn and therefore more irritation; moreover, an older calf is more sensitive.

By Electrical Cauterizer The iron was connected by a three-point 5-amp. plug, since it is important to earth these irons to avoid any risk of shock to either the operator or calf. It was not found possible to overheat the iron; indeed at the "peak periods" of the day it was difficult to heat the iron sufficiently. The operation is easier if the hair is clipped away from the horn bud first; but this is not essential. Pre-clipping also saves the iron from becoming covered with half-burned hair, as it would be where several calves have to be done.

The iron was held to each horn bud momentarily and then the operation repeated. In practice it was found to be impossible to burn the calves too much; their struggles inevitably dislodged the iron as soon as its work was done. When the operation was finished there was a complete ring of seared tissue around the horn bud. The method is illustrated in Fig. 2. The operation is, of course, momentarily painful but the calf appears to feel no distress afterwards.

Table 2 gives the results of the six calves treated. The four younger calves on which the treatment was successful look as if they are naturally polled. Calf No. 15, noted as having "some growth," has thickened, blunted horns, far shorter than normal. Calf No. 16 is developing normal horns.

Table 2. Calves Treated with the Electrical Cauterizer

Calf No.	Breed	Age when Treated	Age when Last Observed	Visible Horn Growth		Remarks
		days	*weeks*	*Right*	*Left*	
18	Cross-bred	4	14	None	None	
17	Ayrshire	7	12	,,	,,	
13	Cross-bred	18	15	,,	,,	
14	,,	21	20	,,	,,	
15	,,	28	26	Some	Some	
16	,,	35	26	Strong	Strong	

Here again, the earlier the operation the less tissue there is to sear away and therefore less pain to the calf. Also, the younger the calf the easier it is to hold. One calf was successfully treated at 4 days, but a week to 3 weeks seems to be the optimum age; that is, as soon as there is sufficient growth to hold the iron in position.

Discussion Both methods proved satisfactory, provided they were carried out within certain prescribed age limits: 1–9 days for the chemical dehorner and 4–21 days for the cauterizer. The chemical dehorning agent has two outstanding advantages over the electrical cauterizer: (1) the operation can be performed anywhere the calf may happen to be lodged, whereas the other method requires a supply of electricity, the presence of a convenient power point, and haltering and leading the animal to that point. There is also the time taken for the iron to heat, which is anything from 15 to 30 minutes. (2) Although there are three operations involved in using the solution, all are simple and practically painless, and they can be done by one man if necessary. With the cauterizer, although it is not necessary to prepare the site first, two men are required, and sometimes even then the calf is difficult to hold.

The chemical method has one disadvantage. If any of the solution is accidentally placed on the surrounding skin the irritation may cause the calf to rub the area and thus impair its action, but this may be obviated by carefully wiping off any such solution immediately.

References

GUTHRIE, J. E. *Vet. Med.* (1947) **42**, 8.

ROWE, J. E. *Farmer and Stock-Breeder* (1947) Oct. 14, p. 2319.

ELECTRICAL PRE-WARMING OF TOMATO-HOUSE SOIL

C. A. Cameron Brown, B.Sc. and E. W. Golding, M.Sc.Tech.

FOLLOWING the published description in 1942 of the Electrical Research Association's simplified method of handling electrically heated hotbeds,* the E.R.A. had been approached at different times by glasshouse growers who were interested in applying the method to warming the soil in glasshouse tomato beds. Their particular problem was the pre-warming of the soil to the right temperature for planting out, and this was finally crystallized by Dr. B. T. Cromwell in the light of his experience and observations both in the Hull area and in the West of Scotland.

It appeared that while a substantial proportion of growers recognized the need for, and the value of, planting into soil at the required temperature—57° to 60° F. at 6 to 8 inches deep—their only method of achieving this was to use the space heating system at as high a temperature as possible and so *push heat down* into the soil. Naturally this process could never be speedy, and that it was uneconomical became increasingly obvious with the scarcity of coal and its rising price. From such evidence as could be obtained it appeared that, depending on the soil temperature at the start and upon the weather following, the period of pre-warming by such means varied from two to four weeks. During this time only a portion of the heat produced by the coal was usefully heating the soil ; the remainder went up the chimney or, equally uselessly, out through the glass and the structure of the glasshouse.

Could this wasted time be saved ? Could the cost of heating be reduced ? Could this be done by electrical methods, which seemed to offer a simpler and more flexible type of installation than buried hot-water pipes ? In accepting the problem, the E.R.A. realized that there was no technical difficulty whatsoever and that their concern was with (a) developing a practicable technique, and (b) establishing whether or not it could be applied for less than the cost of using coal in the ordinary way.

The latter was the more serious question and, in attempting to fix a limit within which the cost must fall for an electrical method to be justifiable, it was not easy to find reliable costs for heating by coal. It was eventually agreed, however, that the electrical method would prove advantageous if the cost of pre-warming, at 1d. per kWh., did not exceed 25s. per 1,000 square feet of soil. At the anticipated loading of 5 watts per square foot, this would mean some 48 hours running time, which would afford a considerable operational advantage over the previous extended running of the space heating system.

Though this may appear to be an over-lengthy introduction to the main matter in hand—the investigation and results—it is most important to get the background to this work clearly in focus. Indeed it may be said now that the results were eventually so well within the "target limit" set above that any doubt or discussion about the exactness of these limits could hardly matter. There was thus a very clear and definite answer to one of the problems—the cost of running. But its determination and the development of the technique involved a most interesting and lengthy piece of experimental research, extending over four years. Its prosecution was, of course, hindered by the war-time lack of materials, but it must be admitted that the

* E.R.A. Report W/T7 "Simplified Electrically Heated Hotbeds" summarized in *Agriculture*, March, 1946.

necessity for seeking out expedients and for improvising have afforded experience which might not otherwise have been offered.*

Experimental Work The experimental investigation fell into three fairly clear-cut stages. Preliminary work, mainly exploring temperature behaviour, was carried out in 1942 at the nurseries of Messrs. J. R. Pearson and Sons, Lowdham, Notts, and with Dr. Cromwell at Auchincruive. In 1943, while this "temperature exploratory" stage was carried on it was incorporated with the beginnings of a working installation; this was done again at Lowdham but the Auchincruive work was transferred to, and expanded at, Mr. J. F. Morton's nurseries at Newmilns, Ayrshire. The transfer of the work to the full commercial stage was made in 1944 at Lowdham, and in 1945 again at Lowdham and also at the nurseries of Mr. D. Smith, Stonehouse, Lanarkshire.

Grid System It was found that a specific loading of at least 5 watts per square foot of soil surface is necessary to ensure the required temperature rise in reasonable time. It was also found that to get a temperature rise of 10° F. at 6 to 8 inches depth the consumption is about 100 kWh. for each 1,000 square feet of soil surface, i.e., costing 8s. 4d. at 1d. per kWh. Further, under the range of conditions met both in the course of the investigations and elsewhere, the required temperature was reached in heating periods ranging from 15 to 35 hours, i.e., costing from 6s. 3d. to 14s. 9d. per 1,000 square feet. Rarely was more than 24 hours required.

The transformer low voltage method was used—a transformer stepping the mains voltage down to a safe value, which was then fed into a system of low voltage wires laid in the soil. The voltage required varies with the *length* of bed involved, but for the sake of limiting variables, it may be said that most commercial requirements will be met by either 15 or 30 volts.

The heating wires are laid on the grid system, whereby wires of appropriate number are laid lengthwise in the bed, being joined at each end by "busbars". For convenience, however, each bed is divided longitudinally in half, the parallel wires in each half being in series with the parallel wires in the other half. Thus the two ends of the complete circuit come back to one end of the bed, or house, and can conveniently be connected to the transformer. In the case of long houses, over 150 feet or so, the feed point may have to be at the centre and current sent "outwards" in each direction (see Fig. 1).

Up to the present, galvanized steel wires have been used but new materials may come along later. The size of wire used depends on the electrical requirements in each case, but for mechanical reasons it is rarely smaller than 12 s.w.g. or bigger than 9 s.w.g. The parallel wires run the whole length of the bed and are strained either individually or in a group; being held in tension, the wires are less likely to be disturbed by digging.

The depth of laying depends mainly on the grower's operational requirements. If he wants the wires out of normal digging reach they will have to be laid at 15 to 18 inches, and this calls for a rather higher consumption of electricity. Generally, however, the wires can be laid conveniently at 9 inches or so; being taut, they will not interfere with single-spit digging and thereafter forking can go on below and between the wires see (illustration on p. iv of art inset).

* E.R.A. Report W/T15 "Electrical Pre-Warming of Tomato House Soil", 1948.
s.w.g. = standard wire gauge.

Technique One advantage of the low voltage method of soil warming is that the transformer—the expensive item—need not be large enough to do the whole area to be pre-warmed. The wire grids can be laid beforehand over the whole area, and the same transformer moved from one section to another, connected up, and pre-warming carried out. For practical purposes, particularly for ease of movement, 15 kW. is about the largest convenient size of transformer. At 5 watts per square foot this will heat 3,000 square feet at a time.

Once the grid wires are in place, therefore, all that is necessary is to connect up the low voltage side of the transformer, which can be handled with safety by the grower's staff, and switch on the mains current. Thereafter the soil temperature is watched and heating stopped when within 1° or 2° F. of the required temperature; it will settle "up" to the required temperature.

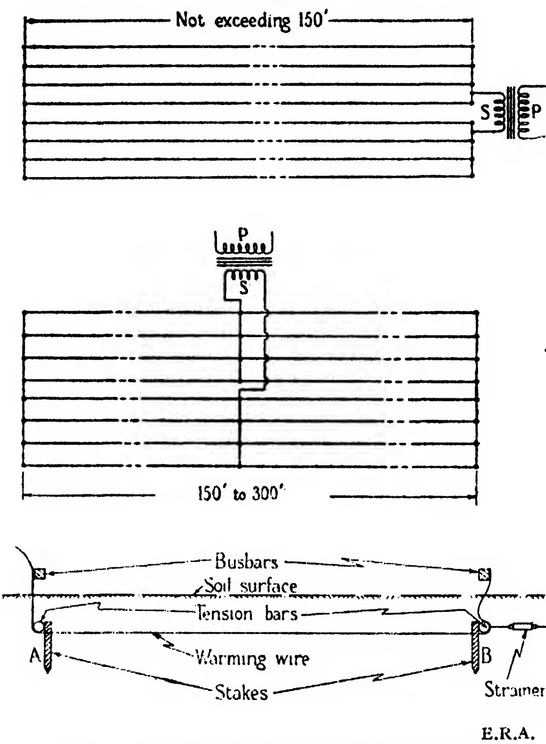


Fig. 1. Grid system of laying warming wires.

If further sections are to be pre-warmed the transformer is moved and connected to the next section of warming grids. Since a warming period of approximately 20-24 hours is required, a planting rate of a section per day can be expected.

Cost of Equipment The cost of the actual low voltage equipment, transformer and wires, varies to some extent with the type of installation and has, of course, varied with labour and material costs. More important still is the variation with size of installation—the cost per 1,000 square feet falls appreciably with the size of transformer and area handled at a time. The following table is a rough guide to the present-day prices of soil-warming equipment.

Size of Transformer kVA.	Cost of Transformer £ s.	Cost of Wire £ s.	Area covered* *sq. feet*
1	22 0	1 10	200
2.5	34 0	2 0	500
4.5	45 0	3 0	900
7.5	70 0	5 0	1,500
10.0	78 0	6 0	2,000
15.0	92 0	8 0	3,000

* As successive pre-warming is likely to be used, any of the above transformers can handle an additional number of areas up to six for the cost of extra wire for each area.

The cost of taking the mains current to the site varies so much with circumstances that no helpful indication can be given. The labour for laying the heating grids is usually provided by the grower.

Further Uses The main problem to which the investigation was directed was the warming of the soil before planting, since it was considered that were this done the normal house heating would hold the temperature. There has been evidence, however, that this is not always the case and that soil warming can profitably be carried on for some time after planting. Where this is done it is rarely necessary to apply it continuously ; indeed warming on one night in four or five appears to be satisfactory. Here again, one transformer can be used to handle a large area by "dosing" it section by section at night.

Another intriguing suggestion is that with soil warming available the house heating can be run at a much lower temperature. This is significant from the fact that a reduction in space temperature from 60° F. to 55° F. may reduce heating costs by *as much as one-third.* There is as yet no really reliable evidence on this point, but there are indications that there is something in the suggestion. It may well be that we are just on the verge of wide uses of glasshouse soil warming by methods similar to those described.

SUGAR BEET YELLOWS AND THE MANGOLD CROP

SUGAR BEET RESEARCH AND EDUCATION COMMITTEE

The virus that causes Sugar Beet Yellows is spread in the field by aphides feeding first on infected and then on healthy plants. This is the only way in which infection is passed on. The virus is not carried in the seed, and seedlings are therefore virus-free, even when the seed from which they are raised is taken from virus-infected seed plants. Thus, every year the root crop starts free from infection.

The aphides which spread the disease in the field are the peach-potato aphis (*Myzus persicae*) and the black bean aphis (*Aphis fabae*). Of the two, the peach-potato aphis is probably the more important, because it usually enters the crops first and is therefore mainly responsible for the early infections that cause most loss.

VIRUS YELLOWS causes heavy losses of sugar, cattle feed and seed. Severe outbreaks have been recorded in four of the last ten years. The yield of sugar beet is reduced by half when the crop is infected in early August, and later infection causes correspondingly smaller losses. The sugar content and processing quality of sugar beet are also adversely affected, resulting in difficulty in extracting sugar from the roots, and less stock feed is produced because the disease reduces the yield of crowns and pulp. The yield of mangold crops is similarly reduced.

The best way to control the disease is to eliminate overwintering sources of infection. Of these, the two most important are sugar beet and mangold seed crops and mangold clamps, but there are many others which are believed to play a relatively unimportant part in starting the disease in young root crops. Efforts are being made to overcome the seed crop problem by planting only healthy stecklings ; the elimination of other sources of infection is the task of every farmer.

Mangold Clamps as Sources of Infection Aphides are able to overwinter in mangold clamps and carry virus from mangold shoots to young root crops. Indeed the aphides which come from mangold clamps contribute appreciably to the aphis population of an area. Large numbers of winged migrants are produced in the clamps in May, and these aphides are responsible for starting outbreaks of Virus Yellows. An extensive survey last spring has shown that the problem of infested mangold clamps exists all over Britain. There is a tendency for the mangold acreage to be denser in areas of smallholdings, but in all the English areas more than half the holdings grew mangolds in 1947. By the beginning of April the number of clamps had been reduced to less than one per square mile, and by the beginning of May more than half of these had been used up. It is believed that the amount of mangolds left in 1948 was exceptionally low as a result of the poor crop in 1947.

The majority of clamps were infested with aphides, except in the north of England and Scotland, and the degree of infestation increased during April. Of the two species of aphides present, the peach-potato aphis was the commoner.

The following precautions with mangold clamps are advocated :

(1) The clamps should be used up by early April, and it is important that all mangold refuse should be cleared up and the site ploughed as soon as the clamp is finished.

(2) Peach-potato aphides are introduced into the clamps on the mangold foliage in the autumn. Careful removal of all leaves and shoots when harvesting greatly reduces the chance of infestation. Mangolds clamped without topping are often heavily infested. If it is necessary to keep mangolds after the beginning of April, the danger of aphis infestation can be overcome by making special clamps of roots from which all leaves have been trimmed.

(3) Measures such as sowing mangolds early and getting crops with good stands will help to reduce virus infection and aphis infestation in the autumn and render clamps less infective.

(4) If clamps are made well away from the fields which are to be cropped with beet or mangolds in the following year, the chance of severe, early attacks of Virus Yellows will be reduced.

(5) Methods for dealing with infested clamps in April need further trial and development ; it has been suggested that if mangolds cannot be fed to stock quickly, the shoots can be trimmed off by hand on to straw which is burnt and the roots stored in a barn ; burning the straw covering is believed by some farmers to be effective.

Minor Sources of Infection Clamps of red beet may be infested with peach-potato aphis, but the number of these clamps is small compared with those of mangolds. They are likely to be only a local problem in areas that supply urban markets, and the extent to which clamps remain in the spring will depend upon the market for red beet in the winter. Precautions should be taken to avoid disease spreading from them, as with mangold clamps.

Although groundkeeping beet and mangolds are often infected with Virus Yellows, they are not an important source of infection because they are not generally infested with aphides. However, their presence is undesirable from the viewpoint of other pests and diseases. They are only a serious problem after difficult harvests. Careful lifting, eating off the tops with sheep, and deep ploughing are preventive measures. In the spring they may be pulled when corn is weeded and their growth can be stunted by the use of chemical weed-killers. Plants growing on sites where sugar beet have been stored in the autumn should be cleared by hand.

Seakale beet, spinach beet and winter spinach are susceptible crops which are grown in gardens and constitute an important source of infection in the vicinity of urban areas, particularly in the south of England. These vegetables are usually grown in sheltered sites favourable for overwintering of the peach-potato aphis, and winged migrants are produced on them in April and May. This could be avoided by treating the plants with derris in October.

Wild beet grows in profusion on parts of the east, south and west coasts. Some are infected with Virus Yellows, but only occasionally are plants found to have aphides on them. Like groundkeepers, they are not believed to be an important source of infection.

EARLY PLANTING OF MAINCROP POTATOES

J. D. Ivins, B.Sc. and N. McDermott
Nottingham University, School of Agriculture
Sutton Bonington, Loughborough

Many factors influence the yield of potatoes for good or ill. Those which are wholly, or partly, in the hands of the grower—for example, healthy seed, manuring, and time of planting—are vital to successful cropping.

Time of planting may be delayed by labour shortage and inclement weather, as happened in the spring of 1947. The late planting may have been responsible for a large proportion of the low yields of potatoes obtained during that year.

To give an indication of the loss due to late planting, a trial was laid down at the Nottingham University School of Agriculture in the spring of 1948. Sprouted (boxed) seed of Majestic certified A (Scot) was used, and plantings were made on three dates, at three-weekly intervals. The lay-out of the trial was in the form of a randomized block and, apart from the times of planting, all treatments were as uniform as possible. Cultivations and manuring were in accordance with local practice. The trial crops were lifted on October 5, 1948, and the results are summarized below:

Date of Planting	Ware (over 2 in.) *tons per acre*	Seed (2 × 1½ in.) *tons per acre*	Chats (less than 1½ in.) *tons per acre*	Total *tons per acre*
April 5	13.20	4.17	0.17	17.54
April 26	12.41	4.07	0.16	16.64
May 19	8.72	3.81	0.17	12.70

The greatest loss occurred with the third planting, where a delay of three weeks resulted in a loss of 3.69 tons of ware per acre—a loss of 3.5 cwt. per acre for each day planting was delayed.

EARLY PLANTING OF MAINCROP POTATOES

Dr. P. H. Gregory, writing in *Agriculture* (March, 1944), referred to the losses experienced by delaying the time of planting unsprouted seed of Majestic :

> It can be calculated that for these particular stocks and cultural conditions, each single day's delay in planting the unsprouted seed in spring involved on the average a loss of 3½ cwt. per acre of final yield.

It will be noted that this figure is identical with that obtained with *sprouted* seed at Sutton Bonington. Such a great loss, however, did not occur in the comparison of the first and second plantings, and the evidence seems to suggest that for Majestic at any rate there is a critical date for planting, beyond which losses of 3½ cwt. per acre may be expected for each single day that planting is delayed. At Sutton Bonington this critical date seemed to be during the third week in April.

The above results confirm that delayed planting may seriously reduce yield.

Although it is well established that sprouted seed produces heavier yields than unsprouted seed, it seems likely that lower yields may be produced by either category if planting is delayed. .

It need hardly be stressed that the ton per acre which may easily be lost by a week's delay in planting, is practically all profit and of inestimable value to the nation.

FARMING AFFAIRS

Suggested Seeds Mixtures A series of suggested mixtures for the 1949 season has been prepared by the National Agricultural Advisory Service in consultation with the Seed Production Committee of the National Institute of Agricultural Botany and the Grassland Improvement Station. The suggestions are general in character and include a range of simple mixtures designed to meet special circumstances of drought periods and extension of the grazing season.

Minor changes have been made in the recommendations, to meet the variations in the supply of seeds available. In particular, the home-grown strains of herbage seeds are in short supply.

1. ONE-YEAR HAY LEYS

A. Ryegrass with Clover (for aftermath grazing)

6	lb.	Italian ryegrass
6	,,	Perennial ryegrass (hay strains)
4	,,	Broad red clover
2	,,	Late-flowering red clover
18	,,	per acre

To this mixture can be added : 2 lb. trefoil on calcareous soils, *or* 1 lb. alsike, especially for wet or clover-sick land.

B. Ryegrass with Clover (hay only)

10	lb.	Perennial ryegrass (hay strains)
6	,,	Broad red clover
16	,,	per acre

2. TWO-YEAR LEYS

C. Timothy and Clover

12	lb.	Timothy (hay strains)
4	,,	Late-flowering red clover
1	,,	White clover (certified S.100 or New Zealand certified)
17	,,	per acre

D. Two-Year Hay Ley on Soils of Lower Fertility

12	lb.	Timothy
4	,,	Alsike
1	,,	White clover (certified S.100 or New Zealand certified
17	,,	per acre

E. Grazing mixture for Short-duration Leys based on Ryegrass, Timothy and Clover

4 lb.	Italian ryegrass
10 ,,	Perennial ryegrass (hay strains)
4 ,,	Timothy (hay strains)
2 ,,	Late-flowering red clover
4 ,,	Broad red clover
1 ,,	White clover (certified S.100 or New Zealand certified)
25 ,,	per acre

F. Simple Mixtures (Hay or Grazing)

(i)

4 lb.	Italian ryegrass
14 ,,	Perennial ryegrass (hay strains)
2 ,,	Late-flowering red clover
2 ,,	White clover (certified S.100 or New Zealand certified)
22 ,,	per acre

or (ii)

4 lb.	Italian ryegrass
14 ,,	Timothy (hay strains)
2 ,,	Late-flowering red clover
2 ,,	White clover (certified S.100 or New Zealand certified)
22 ,,	per acre

or

(iii)

4 lb.	Italian ryegrass
14 ,,	Cocksfoot (hay strains)
2 ,,	Late-flowering red clover
2 ,,	White clover (certified S.100 or New Zealand certified)
22 ,,	per acre

In mixtures E and F, trefoil may be added on calcareous soils and red clover replaced by alsike on acid soils and clover-sick land.

3. LONG-DURATION LEYS (THREE YEARS OR OVER)

This mixture is more suitable for undersowing than for direct seeding. When grazing only is intended, omit red clover

G. Cockle Park Type

3 lb.	Italian ryegrass
5 ,,	Perennial ryegrass (pasture strain)
5 ,,	,, ,, (hay strain)
4 ,,	Timothy (pasture-hay strain)
4 ,,	Cocksfoot (pasture strain)
4 ,,	,, (hay strain)
4 ,,	Late-flowering red clover
½ ,,	White clover (certified S.100 or New Zealand certified)
½ ,,	Wild white clover (certified S.184 or English certified)
30 ,,	per acre

H. Simple Grazing Mixtures

At least 50 per cent of the seed used should consist of certified leafy pasture strains

(i)

14 lb.	Perennial ryegrass
2 ,,	White clover (certified S.100 or New Zealand certified)
16 ,,	per acre

or (ii)

14 lb.	Timothy
2 ,,	White clover (certified S.100 or New Zealand certified)
16 ,,	per acre

or

(iii)

14 lb.	Cocksfoot
2 ,,	White clover (certified S.100 or New Zealand certified)
16 ,,	per acre

J. Lucerne Mixture

(i)

16 lb.	Lucerne (inoculated)
3 ,,	Cocksfoot (certified S.37)
½ ,,	White clover (certified S.100 or New Zealand certified)
19½ ,,	per acre

or (ii)

16 lb.	Lucerne (inoculated)
3 ,,	Timothy (certified S.48)
½ ,,	White clover (certified S.100 or New Zealand certified)
19½ ,,	per acre

or

(iii) 16 lb. Lucerne (inoculated)
3 ,, Meadow fescue
½ ,, White clover (certified S.100 or New Zealand certified)

19½ ,, per acre

K. General Purpose, without Ryegrass

IMPORTANT: Use leafy strains of grasses whenever possible

(i) 3 lb. Cocksfoot
6 ,, Timothy
6 ,, Meadow fescue
2 ,, Late-flowering red clover
1½ ,, White clover (certified S.100 or New Zealand certified)
½ ,, Wild white clover (certified S.184 or English certified)

19 ,, per acre

or

(ii) 6 lb. Timothy
6 ,, Meadow fescue
1½ ,, White clover (certified S.100 or New Zealand certified)
½ ,, Wild white clover (certified S.184 or English certified)

14 ,, per acre

Definition of Types

Perennial Ryegrass
1. Pasture strains: S.23, Kent Indigenous
2. Pasture-hay strains: S.101, Devon Eaver
3. Hay strains: S.24, New Zealand certified, Ayrshire, Irish

Cocksfoot
1. Pasture strains: S.143
2. Pasture-hay strains: S.26, New Zealand Akaroa, once-grown English Akaroa
3. Hay strains: S.37, Danish, American

Timothy
1. Pasture strains: S.50
2. Pasture-hay strains: S.48
3. Hay strains: S.51, Scotch, Canadian, American

Meadow Fescue
1. Pasture strains: S.53
2. Pasture-hay strains: S.215, Danish

Testing of Farmers' Seeds Before the principal kinds of agricultural and vegetable seeds are sold or exposed for sale, they must be tested in accordance with the provisions of the Seeds Act, 1920. Also at or before the time of sale or delivery of the seed, a written declaration must be made to the purchaser giving the prescribed particulars, including the percentage of purity and germination as ascertained by test; with cereals, the percentage of purity need not be given. Purchasers should ensure that this information is given to them.

Very often a farmer will have saved his own seed (particularly cereal seed), or he may have seed on hand which has not been tested during the current season. The most careful cultivation cannot produce a good crop from poor seed, and in his own interests every farmer should take care to avoid sowing seed that is not up to standard. Whether or not he grew the seed himself, a farmer can get samples tested at the Official Seed Testing Station, Huntingdon Road, Cambridge, at the cost of 6d. each. They should be accompanied by an undertaking that the test is not required in connection with a declaration for sale, and a postal order or stamps (not coin) for the fee.

If a test is required for the purpose of making a declaration for sale as required by the Seeds Act, the ordinary fees applicable to seedsmen will be chargeable. Particulars of these charges may be obtained from the Official Seed Testing Station or from the Ministry of Agriculture and Fisheries, 14-21 Chester Terrace, Regent's Park, London, N.W.1.

The samples submitted must, of course, be fairly representative of the bulk from which they are taken, and not less than the following quantities :

Garden swede, garden turnip, garden cabbage, garden kale, garden kohlrabi, Brussels sprouts, broccoli, cauliflower, carrot, parsnip, onion	¼ oz.
Wild white clover	1 oz.
Ryegrasses, meadow fescue, cocksfoot, crested dogstail, timothy, alsike clover, white clover (other than wild), field turnip, swede, rape, field cabbage, field kale, field kohlrabi, mangold, beet and sugar beet	2 oz.
Wheat, oats, barley, rye, tares or vetches, red clover, crimson clover, trefoil, lucerne, sainfoin, flax, linseed and mixtures of grasses and clovers	4 oz.
Peas (field and garden), beans (tick and winter), dwarf beans	4 oz.
Broad beans, runner beans	8 oz.

Official Seed Testing Station : 1948 Report The steady increase in the number of seed samples received for analysis at the Official Seed Testing Station, Cambridge, during the past seven years reflects the importance which seed merchants and farmers are attaching to the need for better seed :

1941–42	1942–43	1943–44	1944–45	1945–46	1946–47	1947–48
66,541	74,528	75,834	76,692	79,157	80,019	82,737

Every year many investigational tests are also necessary to solve problems connected with routine testing. During 1947-48 these numbered 1,285 as against 1,795 in 1946-47. Tests to determine moisture totalled 939, as compared with 896 in 1946-47 and 1,027 in 1945-46. The increase in the number of celery seed samples submitted for examination for disease infection is encouraging—152, as compared with 109 and 75 in the two previous years. Taylor and Dillon Weston, reporting in the August issue of *Agriculture* the result of their survey in 1947, expressed considerable concern regarding the extent to which celery seed in this country is infected with Celery Leaf Spot.

During the year there was again a large number of weed and other seeds sent to the Station for identification.

"Head" samples received in connection with the Wild White Clover Certification Scheme numbered 30, while the type samples sown from certified pastures numbered 26. In 1947 the numbers were 80 and 29 respectively. The customary inspection of the plots from the "head" samples was made by the Plot Inspection Committee in July, 1948.

A Seed Testing Course was held from May 25 to June 28, 1948. Nineteen candidates attended, fourteen of whom came from seed firms, four from the Official Station, and one from the Ministry of Agriculture and Fisheries. In the subsequent examination, fourteen candidates were successful. Four passed in the practical work but failed in the written papers.

Sewage Sludge and Sludge Composts The result of eight years' investigation under the auspices of the Agricultural Research Council into the manurial value of sewage sludge has been summarized in the Ministry of Agriculture and Fisheries Technical Communication No. 7.* The main points are :

1. Sewage sludge has a moderate manurial value as a source of slowly available nitrogen and phosphate. It provides very little potash. In general the crop-producing power of sludge taken from drying beds is much less than that of an equal weight of farmyard manure. The physical effects of sewage sludge on the soil are less pronounced and of a different kind from

**The Agricultural Use of Sewage Sludge and Sludge Composts.* Free and post free from the Ministry of Agriculture and Fisheries, St. Andrew's Place, Regent's Park, N.W.1.

those of farmyard manure, because sewage sludge lacks the coarse fibrous ingredients derived from straw and other plant residues.

2. Only sludges in a comparatively dry state (less than about 50 per cent moisture) are convenient for transport and spreading. As they must be applied at heavy rates and are sometimes difficult and unpleasant to distribute, their use must depend on economic and local considerations, so that no general statement can be made on their agricultural value.

3. Digestion improves the physical condition of sludge and the availability of its nitrogen. These improvements are still more evident when the digested sludges are shed-dried and pulverized.

4. Certain sludges from sewages of industrial origin contain metallic and other wastes which may render their phosphate unavailable and may sometimes be harmful to crops in heavy dressings. Such sludges and also those to which iron salts have been added in the course of treatment at the sewage works should be tested on a small scale before they are used extensively.

5. Satisfactory rotting of straw takes place in compost heaps prepared with about one-and-a-half parts of sludge dry matter to one part of straw, provided the heap is satisfactorily wetted and aerated. Field trials have shown that such composts are better than sewage sludge alone because they supply some potash and have better physical effects on the land. Although composts of sludge and straw have proved somewhat inferior to equal quantities of farmyard manure in field trials, they provide convenient methods of adding bulky organic manures to market-garden soils. Only a limited number of field experiments have been carried out on composts of sewage sludge and town refuse ; some of these have given useful results.

6. No instance is known in which the use of sewage sludge as a manure for a crop for human consumption has led to an outbreak of typhoid or dysentery infection, but special precautions should be taken in using sludge for salad and other crops to be eaten raw. Wet sewage sludges should never be used for such crops, and sewage sludges from drying beds only when they can be applied to the land some months before these crops are to be sown.

Horticultural Produce : Cooperative Marketing

In the two well-known reports, Economic Series Nos. 15 and 25, published in 1927 and 1935 respectively, the general subject of co-operation in marketing was touched upon only lightly. The issue of a new report* specifically devoted to the subject of co-operation in all its aspects should be generally welcomed, for it not only completes the information available in the valuable series of marketing reports, but provides a useful source of information on one of the most progressive aspects of modern commercial horticulture, considered in its wider application.

The present report, the result of a recent investigation undertaken by Mr. L. G. Bennett of the University of Reading on behalf of the Ministry, covers a wide field. Although, in all, a total of thirty-eight co-operative organizations have so far been established in England and Wales, owing to some degree of merging the number in active operation is thirty-four. The history of the movement outlined in the report shows that there has been a continuous, though rather slow, development of this type of growers' organization since 1905, when the Swanwick and District Fruit Growers' Association was formed.

* *The Cooperative Marketing of Horticultural Produce in England and Wales*, (Economic Series No. 49). Ministry of Agriculture and Fisheries. H.M. Stationery Office. 1*s*. 3*d*. (1*s*. 5*d*. by post).

It is especially worth noting that the co-operative movement is by no means confined to the marketing or produce, for societies have been formed which aimed at supplying growers with any item required in their work as producers. In one instance also a co-operative body was formed to operate a treatment plant for bulbs in order to control the eelworm pest. Nor should the fact be overlooked that two of the leading research stations in England came into being as a result of co-operative action on the part of the growers concerned.

But one of the most useful and progressive forms of cooperative action in the horticultural industry is concerned with the handling and marketing of fruit and vegetables, and much of the progress made toward improved methods of packing and grading of apples and pears can be attributed to the several cooperative packing stations successfully operated for long periods.

This latest report is a valuable publication; perhaps, looking to the future, the two most interesting and useful sections are those which deal with success and failure amongst growers' co-operatives and with the setting up of new organizations.

Nature Month by Month—January In the animal kingdom, nature's winter sleep is by no means all-embracing. Although the dormouse slumbers so deeply that nothing will wake it for months to come, while grass snake and toad, newt and lizard, are safely tucked away until the coming of the spring, by day the squirrel, by night the badger, and even the hedgehog, may be seen out and about. The hedgehog is a restless sleeper, never reaching the coma-like condition of the wintering dormouse, and neither badger nor squirrel is a true hibernator. Fox and hare, rabbit, stoat, weasel, and many others, have a living to get, no matter what the season.

Insect life, it is true, is mostly dormant; but a bright, mild day, even now, may tempt from hibernation peacock, tortoiseshell or brimstone butterflies, especially the last. Not so long ago I saw a brimstone dancing gaily over snow. The male winter moth and sundry others will be on the wing at nightfall, and if the air is mild enough a bat or two may wake and hawk for them around the street lamps. The queen bumble-bees, and the queen wasps, too, are snug in their winter dormitories, waiting for the spring sunshine to call them out again.

This is the lean season for the birds, and in frost or snow it is leaner still. The hours of daylight may be none too many for storing heat and energy against the chilly winter nights. But a few of our birds, even thus early, will be thinking of home-making; certainly the ravens and, maybe here and there, a pair of crossbills. Our winter visitors from overseas are with us; fieldfare and redwing are busy in the paddocks and among such fruits as still deck the hawthorn and the wild rose.

In sheltered corners one comes upon surprising green things. In the woods there are mosses, vivid as emeralds. On the moor I could, I think, still find gorse in bloom; somewhere, the yellow blossom is almost sure to be found in any month of the year.

January is the season of hope. Doubtless there is hard weather to come before spring is here again, but the turn of the year is the time for looking forward.

F.H.L.

BOOK REVIEWS

British Plant Life. W. B. Turrill. Collins. 21s.

Dr. Turrill, a well-known authority on the subject of British vegetation, is Keeper of the Herbarium at the Royal Botanic Gardens, Kew. This excellent new book of his will therefore be a welcome addition to existing botanical literature, although it should be noted that it differs fundamentally from other works on British wild plants. The first sections are devoted to the history, probable evolution and geographical relationships of British flora. Later chapters deal with habitat factors, plant communities, variation, adaptation and natural selection, the study of heredity and the continuing changes in British plant life. The author has ably summarized the work that has so far been done on the wild plants of Britain and points the way to further, more intensive study—especially of individual species. Anyone with a love of plants and facilities for growing them under different sets of conditions and competent to make careful observations can, Dr. Turrill points out, contribute substantially to our knowledge.

The agriculturist will find much food for thought throughout the book, particularly where plant environment or "habitat factors" are discussed. For instance, of the oak the author states that it is "attacked from the acorn stage till that of old age. A large number of animals eat the acorns, the principal offenders being rabbits, mice, voles, pheasant, wood-pigeons, and jays. In the seedling stage mice and rabbits are responsible for the greatest number of deaths. In the adult stage the oak provides food and environment for more species of insects and other invertebrates than does any other British plant". With regard to bracken, "the change from cattle (or mixed cattle and sheep) to sheep grazing has been suggested as one cause of the great spread of bracken, particularly in Wales and Scotland".

The book is one of the *New Naturalist Series* and follows the same general lines as earlier volumes ; the fifty-three excellent colour photographs of British plants in their natural settings are a special feature of the book.

F.N.H.

Year Book of Agricultural Co-operation. Edited by The Horace Plunkett Foundation. Heffer. 15s.

Most of the chapters in the Year Book of Agricultural Co-operation for 1948 are of rather specialist interest. They survey the progress of many kinds of co-operative farming in many countries, from the collective farming of Soviet Russia to the interesting small experiments in Kenya and Nyasaland. There is one chapter, however, which is of great direct interest to farm readers in Britain. It is a record of the first part of an investigation into the mechanization of the small farm in England and Wales. It is written by Miss E. M. Owen who made the survey, and is in fact a succinct and most useful account of the work of Britain's machinery contract services, both those run by private individuals and those by County Agricultural Executive Committees. The few independent parish machinery pools still existing in England and Wales are also mentioned.

The author introduces her subject by sketching the history of the formation of the Machinery Departments of the Agricultural Executive Committees during the late war. She points out that the Committee services were intended primarily to help the smaller farmers who, by 1939, were not, generally speaking, mechanized to any great extent. Except where intensive cultivation of cash crops was undertaken, a high capital expenditure per acre on machinery could not reasonably be undertaken by small farmers. The investigation being made by The Horace Plunkett Foundation is seeking to assess the future needs of the smaller farmers.

H.J.H.

Practical Aspects of Income Tax for Farmers. John R. Harvey and F. H. Dymond. S.P.B.A. Supplies Ltd. 1s.

Published concurrently with the Ministry's own *Farmers' Income Tax*, this 24-page booklet is designed to tell farmers (whether poultry farmers or not) about many of their rights and obligations connected with Income Tax, and the practical details involved. The authors appear to imply that, for a large number of small farmers, the abolition of Schedule B will lead to a burdensome inquiry into profits. They do not mention the Government's undertaking that farmers whose income is obviously not big enough to make them liable to tax will not be asked to make returns or be assessed ; and the reader is left with the impression that the small farmer may be dismayed by the prospect of assessment, and perhaps inclined to regard the Inspector of Taxes askance.

That apart, the reader will be helped to understand the assessments made upon him and to choose between some of the options available. In a publication of this length the omission to mention some important arrangements, both statutory and extra-statutory, is unavoidable.

C.W.R.

Bovine Tuberculosis, including a contrast with human tuberculosis. JOHN FRANCIS. Staples. 25s.

Although much has been written about bovine tuberculosis, this is the first publication which gives a comprehensive review of the subject. It includes chapters on the incidence of tuberculosis, pathogenesis, tuberculosis of bovine origin in man, detection of tuberculous cattle, vaccination, and the control of bovine tuberculosis.

The available information on the incidence of the disease in most countries is given and the factors which influence it are fully discussed. For this country Francis accepts a recent estimate that 17-18 per cent of the cattle are affected.

The chapter of pathogenesis is perhaps open to criticism—indeed it has been criticized in scientific journals—but it does give a stimulating comparison between tuberculosis in cattle and in man.

In these days when it is common knowledge that bovine tuberculosis may readily infect the human subject, it is of considerable interest to be reminded of the old controversy on this question. It is rightly claimed that efficient pasteurization renders milk safe; the suggestion that pasteurization of milk from tubercle-free herds may be necessary to protect the public against other milk-borne infections is not so readily acceptable.

Tuberculin testing is adequately discussed, but Francis exaggerates the difficulty of diagnosis by clinical methods.

All the methods of control which have been used (many of which are now only of historical interest) are mentioned. Modern methods depending on the tuberculin test are more fully discussed.

This is a book to which reference can usefully and readily be made for information on bovine tuberculosis in all its aspects.

J.N.R.

Genetics. H. KALMUS. Pelican Books. 1s. 6d.

This is not quite the type of book one expects in a "Pelican," since the style on the whole is that of a textbook. The author has, however, used as few technical terms as possible, and a useful glossary of those which have been employed is given. The man with no knowledge at all of genetics will find little of it easy reading, but if he can be persuaded to study each page carefully he will obtain a good and up-to-date knowledge of the subject and its implications.

More attention is given to the zoological than to the botanical aspects of genetics—thus in a list of journals no mention is made of "Plant Breeding Abstracts," though "Animal Breeding Abstracts" is listed. It is pleasant to be able to record that, although too small to be absolutely clear, the diagrams of the two types of nuclear division, mitosis and meiosis, are not some twenty years out of date, as is so often the case. It should, however, be noted that the structure labelled chiasma in stage 6 of Fig. 14 is not a chiasma but the centromere. The chapter on the economic aspects of genetics is much too short to be of interest to the agriculturist. Other topics are also dealt with very shortly, and one is left with the impression that the author would have produced a more readable book had he not tried to deal with so many aspects of genetics in less than 170 pages.

H.W.H.

Printed in Great Britain under the authority of His Majesty's Stationery Office by C. Nicholls & Company Ltd., The Philips Park Press, Manchester, London and Reading.

Please mention the JOURNAL *when corresponding with Advertisers*

Please mention the JOURNAL *when corresponding with Advertisers*

Agriculture

PUBLISHED 6d MONTHLY

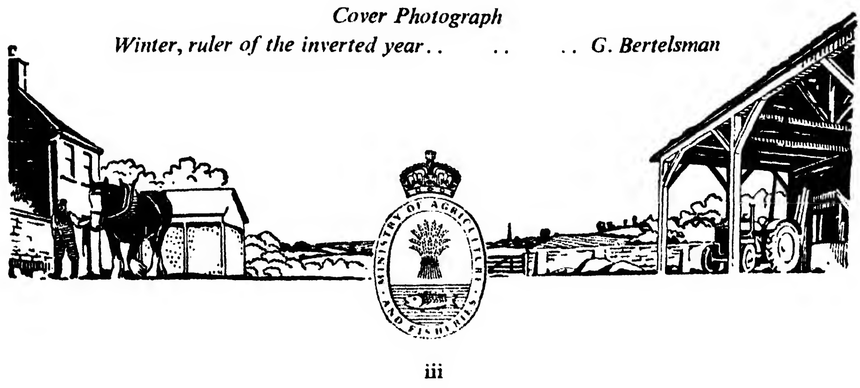
AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

Editorial Offices: St. Andrew's Place, Regent's Park, N.W.1 (*Phone: WELbeck* 7711)

VOL. LV   No. 11   FEBRUARY 1949

Contents



AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LV | No. 11 | FEBRUARY 1949

A PLAN FOR THE PRODUCTION OF WINTER GRASS

SIR R. GEORGE STAPLEDON, C.B.E., M.A., F.R.S.

WRITING in November, I cannot foresee what the conditions will be in February when this article comes to the farmer's notice. As likely as not they will be grim, with little or no grass, either shrivelled and burned or green, to be eaten on the fields. This melancholy state of affairs will perhaps accentuate the farmer's idle regrets that he did not make more strenuous efforts to conserve greater quantities of summer grass as silage, and while looking out woefully on his attenuated hay ricks cause him to mutter reproachfully, "Poor stuff anyway, but better than nothing". Nothing I write now can help the farmer to surmount his present difficulties, but perhaps I may persuade him to make a good resolution and to take steps not to be caught out quite so badly next winter.

Lessons from Natural Grazings It is very instructive to watch animals which are wintered on rough grazings and receiving little or no hand feed. I have watched sheep on the open (and unimproved) Welsh Hills, and steers on virgin downland. Both classes of animal and on both situations spend something like two-thirds of their time working hard and grazing tight to obtain as much short and green leafage as they can from closely cropped areas, and about one-third of their time eating dry and dead vegetation. It is difficult to estimate the dry matter contribution of each type of eatable which the animal takes in the twenty-four hours.

From the one type he wins very little per bite, while from the other, in sheer dry matter, he earns a full reward. Probably at the highest he does not obtain more than about 20 per cent, and perhaps no more than 10 per cent, from the short, green herbage. I took samples from the two classes of eatables on a virgin down sward early in March, 1948. The following figures (calculated on dry matter), taken from chemical analyses kindly prepared for me by Mr. R. O. Davies, Head of the Department of Agricultural Chemistry at Aberystwyth, are interesting.

	Closely Grazed and Green	Tufted and Winter Burned
	per cent	*per cent*
Crude protein	21.39	9.42
Crude fibre	22.58	31.49
Phosphate (P_2O_5)	0.61	0.16
Lime (CaO)	0.92	0.47

It will readily be apparent from these figures that even a comparatively small (in bulk) supplement of the green herbage to the tufted and winter burned would greatly improve the gross diet taken by the animals. The green

vegetation would also contain much more water than the dead and dried, a succulence which, in relation to the character of the eatables as a whole, might well be of decided advantage to the animal.*

It seems to me that these figures in support of the animal's behaviour give us the key to providing the animal with abundant winter grass by the adoption of appropriate acts of husbandry. A sudden flush of winter grass, or but a small tonnage of nutrients in a grazable condition, does little to solve the practical problem, and may only upset the even (if not highly pitched) tenor of the animal's winter life. If grass standing out on the field is adequately to replace, or appreciably supplement, hay-*cum*-silage, it must be produced in quantity and be available in quantity over a long period. This, I think, is axiomatic, but is not sufficiently appreciated when we are considering or planning the production of winter grazing. Ideally we should aim at producing vast quantities of green and actively growing protein-rich grass in the winter, but it is quite impossible to obtain it in sufficient quantities, except in exceptionally favoured areas : our climate sees to that! There are such areas in this island, but they do not form a large proportion of the whole. What we can do is produce far larger amounts of both classes of eatables as taken by the steers grazing the Downs, and produce the dry and more bulky portion with a decidedly better chemical composition than that given under natural conditions. Our aim should be to provide the animal with high-class representatives of both classes of vegetation on one and the same field. By adopting such a plan we should be able to produce winter grass of sufficiently high quality (taking both classes of eatables together) and in sufficient quantity to make a really telling contribution to winter feed. I propose to deal with the question from this point of view and to outline a plan of procedure.

A Working Plan I argue that if a particular acreage of land could be made to provide winter grazing for a goodly head of stock from, say, December 1 to March 15, then we should not expect that acreage to earn money in any other way for the rest of the year. Any hay, silage or grazing obtained as a result of the management necessary during the spring and summer for the production of maximum grazing in winter should be considered in the nature of a free gift. As matters stand today most farmers expect such winter grazing as they may get to be in the nature of a free gift, which is quite ridiculous.

I would select a large field and aim at having about one-third in succulent winter-green herbage and two-thirds in standing adult and largely "burned" mature material—in foggage, in fact. I would set the field out in strips in such a way that herbage and foggage strips alternated in the right proportions across the field. It is important that the animals should be encouraged to pass freely from one type of vegetation to the other. Both the herbage and foggage portions would be established by sowing the correct seeds, and the whole field would be sown at one operation and without a cover crop.

The Herbage Strips The herbage strips will be called upon to provide not only succulent high protein and green winter grass, but they will also be chosen by the animals as night camping grounds and should, therefore, be resistant to poaching. To fulfil these requirements

* The steers on the virgin down intermingled bites from the short, green herbage with bites from that which was dried and tufted. It is probable, therefore, that whereas in the spring a certain amount of fibrous matter is needed to set off too much succulence, in the winter succulence is needed to set off feed with an unusually high percentage of dry matter.—Stapledon (1948).

a well-developed root system will be essential. A good root system is largely a result of long periods of unimpeded growth during the growing season. The appropriate non-winter management would therefore be to take silage cuts, or a hay crop followed by a silage cut. Since we shall want the herbage strips to provide winter grass with a crude protein content of about 20 per cent, the herbage must not be left to stand too long, so that a final cut would be taken in September or October, according to the species used. Applications of nitrogen immediately after the final cut will (a) encourage growth, (b) make for winter greenness, and (c) tend to increase the protein content of the leafage. Because nitrogen will be used freely—an application should also be given when growth is starting in the spring—it will be a matter of the first importance to maintain the lime, potash and phosphate status of the soil at the correct levels.

Since the field will be laid out in strips and managed by the mowing machine during the growing season, there is no reason whatsoever why all the strips should be sown with the same seeds mixture. There will be no fear of highly differential grazing in the winter, for no matter how clever the husbandry there will be no surfeit of grass. On balance it would, I think, be an advantage to have two seeds mixtures, the one based on perennial ryegrass S.23 and the other on timothy S.48 and meadow fescue. Although white clover, as such, would not contribute to the winter grazing, it would be wise to include a large white clover such as S.100 in each mixture for the good of the grass. I say a large white clover because S.100, for example, withstands the amount of toppage produced by a periodic hay crop or by letting up to silage. More experiments are needed both as to the most appropriate seeds mixtures and as to management, and perhaps particularly as to the date of the last cut before letting up to grow on for the winter. In the matter of seeds mixtures, the inclusion of crested dog's tail (a decidedly winter-green grass) in the ryegrass mixture might well be an advantage. Rough-stalked meadow grass makes good winter growth and is winter-green, and it is possible that a third mixture based on this species, perhaps with the crested dog's tail, would be justified. Red fescue (preferably, I suggest, S.59) should also be considered ; it makes good growth, is reasonably winter-green and affords added protection against poaching. Its inclusion to the extent of 1-2 lb. in all mixtures might be an advantage. Since we shall be working in strips and controlling wholly with the mowing machine, there is no reason why the plough should not intervene and particular strips be sown each year with that excellent winter grass—Italian ryegrass. It may be argued that it is not possible to maintain, and certainly not possible to establish, swards without the competent assistance of the grazing animal during the growing season. In a series of experiments which I laid down in the autumn of 1947 I have certainly contrived to establish, and I am in a fair way to maintaining, my swards, despite the fact that no animal has been on the field.

The Foggage Strips Here we have to cater for bulk and we can do so only by holding back mature and summer-grown leaf and stem until the winter grazing period. What properties, then, should we look for in our foggage plant? Clearly the leaves should be as winter-green as possible ; they should be held to the stem and not blow away ; they should be lifted from the ground and not fall into dense cushions—leafage in dense cushions will soon rot, particularly under continuous trampling. Despite its name, Yorkshire fog is about the worst of foggage plants ; it cushions badly and rots quickly. Perennial ryegrass tends to form dense cushions and to rot too quickly. Cocksfoot "lifts" decidedly better than ryegrass and, although it is not particularly winter-green, its leaves are re-

sistant to rotting and it can be carried into the winter in great bulk. Timothy also "lifts" well and is considerably more winter-green than cocksfoot, but will not produce quite so much bulk. Red fescue, particularly S.59, bulks fairly heavily and is fairly winter-green; it does not cushion badly and is resistant to rotting. Meadow fescue bulks well and is fairly resistant to rotting but tends to cushion when carried over in bulk. In the present state of our knowledge I would say that the three most suitable foggage grasses are timothy, cocksfoot, and red fescue.

The next point to settle is the method of culture. It is important to permit a good current of air through the standing plant and to prevent trampling on the leafage. A healthy development of roots is essential to ensure bulk and as a safeguard against poaching. There is strong evidence to suggest that the above needs will best be met by growing our foggage grass in widely spaced rows (as for seed production), and by adopting this method the heaviest yields will be obtained. The bulk of leafage produced by cocksfoot and timothy in widely spaced rows has been an outstanding feature noticed by farmer seed growers. Griffith and Hutton[1] successfully used such rows (timothy) in the wintering of sheep on the lands of the Cahn Hill Improvement Scheme, and more recently Hughes[2] has reported on the successful wintering of cattle on cocksfoot rows. Hughes's evidence is of added importance because he found that the animals eating the foggage tended to walk between (and not on) the rows. The fact that there was no excessive poaching between the drills was attributed to the massive root system developed by the cocksfoot. The yield of foggage in January was 30 cwt. of dry matter per acre, with a crude protein content (of the dry matter) of 8.8 per cent. Space will not permit of a more detailed consideration of the considerable but rather diffuse evidence available, but I think it may safely be concluded that the right way to grow foggage is in widely spaced rows. Since on my plan we shall be working in strips, I would advocate using more than one species. It would be wise to allocate rather more than two-thirds of the strips to cocksfoot and timothy, perhaps at first devoting slightly more ground to cocksfoot than to timothy. The remaining third should be made over to red fescue, S.59, and a few other grasses for test. I would also include burnet, which is winter-green and rich in protein.

It is essential that the soil should be kept adequately supplied with lime, potash and phosphates, and that nitrogen should be given in ample doses. The two most important points in management to be settled are the number of times the produce should be cut during the growing season and the date of the last cut. I repeat: the greater the unhampered growth, the greater the root system and the greater the bulk of winter grass. In the trial conducted by Hughes the cocksfoot was allowed to grow right on after being cut for a seed crop. In this case the herbage available in the winter was consequently the accumulated growth since July, and because we must have bulk I would put the first week in August as absolutely the latest date for a last cut. It would be sensible to take a hay crop as the first cut, and then perhaps to take a second (and last) cut as a light silage crop towards the middle of July. It might, however, be most advantageous to take only a hay crop and allow all subsequent growth to carry into the winter. Here there is need for much experimenting, and with the strip method I have advocated it would not be difficult to cut at different date ranges. Nitrogen should be applied in the spring as soon as conditions are favourable to growth, again directly after the hay cut and, experimentally at all events (on some of the strips), at the end of August or early in September. To encourage growth and a healthy root development, inter-row cultivation should be conducted in the spring and until the growth is heavy. Here again, there is

need for much careful observation and trial. When winter grazing is started the field should be taken in sections, divided by a temporary fence running across the strips. The farmer should note carefully the behaviour of the animals: how they divide their time between the herbaceous and foggage strips and where they camp are very important points. All the evidence so far available suggests that they will go for both types of eatables, and that they will not camp on the foggage rows.

I make no apology for putting forward a plan which, as such in all its details, I have not tested myself, and which has nowhere been completely tested. It is, however, a plan based on long experience, much observation, and a very large number of devious experiments conducted by many hands and from many different points of view. My main reason for making these suggestions in terms of a categorical plan is that in matters of husbandry, and perhaps particularly in matters of grassland husbandry, the farmer himself must always contribute quite as much as, and in the long run probably more than, the scientist to the solution of practical problems. I have made my suggestions; that is my province—my only province. It is for the progressive farmer to test them and then improve upon them. That is the way ley farming has progressed, is progressing and, with ever-increasing momentum, will continue to progress.

References

1. GRIFFITH, M. and HUTTON, P.M.G. The Wintering of Sheep on Temporary Grasses. *Welsh Journal Agr.* (1936) **12**, 126.
2. HUGHES, G. PEARSON. The Utilization of Foggage. *Agriculture* (June, 1948) 98.
3. STAPLEDON, SIR R. GEORGE. Pastures Old and New: The Animal's Point of View. *Agriculture* (September, 1948) 231.

NEW LEYS IN ESSEX

P. J. O. TRIST, B.A.
County Agricultural Officer, East Suffolk

IN 1939 the total permanent pasture in Essex was 302,800 acres; today it stands at 163,600 acres. The ploughed grassland has made way for increased arable production, which in turn has paved the way for new grass. Most of it represented a vast stretch of water grass and some thousands of acres of worn-out pastures gradually disappearing under scrub. During the past five years many of these acres have gone down to new leys and, in consequence, have released many more acres of old pasture to come under the plough. Essex can produce good grass, but the county has its own soil and weather problems which make the growing and maintaining of good grass rather difficult, compared with conditions favouring some counties. There is a variety of soils in Essex which can broadly be divided between London and boulder clay, alluvial marshes, and light gravel land. The clays and alluvium are heavy, wet and difficult to work, and the light lands suffer from drought. There are other problems to discuss later on, but for the moment we must recognize that other counties also have their problems, and that if good quality grass is needed problems must be faced and the difficulties tackled.

NEW LEYS IN ESSEX

The need today, and for many years to come, is increased agricultural production : new grass can make a very important contribution. The total cattle population of Essex has increased from 112,700 in 1939 to 117,000 in 1948, yet the total area of grassland is 139,200 acres less than it was in 1939. Many farmers who have sown new leys find themselves able to keep at least one and a half times as many cattle as was previously possible on old pasture, and their milk production has increased accordingly.

The grass potential may immediately be queried and the question asked, for how long will it last ? This will depend more on management of the leys than on weather problems and the type of leys sown, although the type of grasses sown under different conditions will play an important part. In addition we must remember that the previous large acreage of so-called permanent pasture is neither necessary nor economical. If we accept a high standard for cereal crops, we should be logical towards grass production. Unless a 3- or 4-year ley shift is being practised, a ley can and should remain only as long as it continues to contribute quality grazing ; that is, long before the bents and buttercups begin to creep in again, the ley harvest is over. This point is aptly illustrated by derelict lucerne layers ten years old or more, which show an occasional lucerne plant amidst a bed of watergrass and couch. This lucerne layer is as derelict as an old ryegrass ley which has reverted to natural grasses to the exclusion of the original ryegrass sown. The system of ley farming is by no means new and is today spreading appropriately into general farm economy. The maintenance of fertility is of prime importance, but there are changes in our livestock population relative to our arable acreage which necessitate some other methods of maintaining fertility. More acres of better grass carry a greater head of stock. Controlled and intensive grazing will benefit the ley and build up fertility from excreta and clover which sooner or later are ploughed under for succeeding crops.

On the London and boulder clays of Essex it is quite practicable to practise ley farming. On the light gravel soils there are possibilities but difficulties also. On the alluvial marsh land the system is impracticable and indeed uncalled for, although this by no means rules out the possibility, or the necessity, of improving these grasslands by other methods. Ley farming should be interpreted broadly ; the term is not necessarily meant to convey a system of taking the plough back into each ley every three or four years. The system can be elastic and leys can remain as long as they are useful, but the principle should be to avoid returning to permanent pastures

The common enemy of the Essex clays and marshes is water, even though a considerable part of the county has a low annual rainfall (about 20 inches) —a fact which handicaps the light lands more seriously than the clays. Owing to the paramount importance of surface- as well as under-drainage, the London clay is ploughed on stetches which vary from 7 feet 6 inches to 8 feet 3 inches in width, whilst the alluvial lands in many areas are still kept on the stetch and the bed. This creates a problem in getting adequate consolidation for reseeding, but during the war it was found practicable to throw four and sometimes six stetches together, according to the lie of the land, making lands of 30 or 45 feet ; provided sufficient water furrows were drawn, the land was kept reasonably dry under new grass.

Before discussing the methods and problems in establishing new leys on these soils, a word about some old permanent pastures is necessary. It is only common sense to leave a limited area of old pasture unploughed until the new leys have become hardened with age, otherwise the life of new grass will be handicapped from the start. Poaching has been the death of many acres, and if new grass keep is available in the autumn, and the farm is not

too well supplied with winter fodder, a decision has to be taken whether new grass should be poached or foregone as keep. If an old pasture is available, straw and roots can be fed out and grazing can be continued with less anxiety about damage to the old sward, but this does not prevent either mechanical or fertilizer treatment being given to the unit.

Clay Land The basic essentials of successfully establishing grass on the clays are no different from the requirements on other soils. These are : an adequate supply of fertilizer in acid-free conditions, on a clean, fine and firm tilth (the details need not be elaborated here). By following the rules of clay husbandry, a good tilth can be obtained. The land must always be ploughed before the frosts, and provided there is an open spring after frosts, a tilth can be made relatively easily ; but a mild frost-free winter, followed by a wet spring and March winds, renders a clay tilth for a ley absolutely impossible. The clayland farmer has to be patient ; for whatever the tilth required, the land is either fit to work or it is not, and there is no half-way stage without disappointing results.

The system of direct reseeding has been criticized as wasteful when stored fertility can be cashed in a rotation prior to reseeding. Whatever the merits of this argument, the system is practicable on the London clay. Few cows are outwintered, and therefore the grassland is free on the average up to early- or mid-April, according to season. Thus, if the land is ploughed by the end of the year, it will afford late back-end grazing, and only the period from mid-April to early June is lost for grazing whilst the new seeds establish themselves. This period of a maximum of eight weeks' loss of grazing is compensated by new grass of greater productivity which provides a longer grazing season. The initial operation is the key to success : a wide furrow laid as flat as possible and completely burying the old turf at a depth no greater than 5–6 inches. As soon as the land is dry in the spring, the ring roller should be used for consolidation—that is, before any harrowing or discing. The subsequent use of disc and roll in tandem is most effective for a good tilth, and a greater appreciation of the value of the pitchpole would be all to the good.

The Essex argument in favour of seeding under a nurse crop to provide shade is not too strong, but is based on rainfall difficulties and the natural desire of the arable farmer to take some crops prior to seeding back. A good nurse crop can be provided by adding a bushel of oats to the mixture. This allows earlier grazing, which is beneficial to establishment, and the ley in its early stages has a better chance on its own without competition with a cereal for plant food, to say little of the importance of light. Shallow ploughing, adequate use of the roller and early grazing to encourage quick growth of the sward are all factors tending to avoid drought cracks in clay. The use of a heavy flat roll when the new grass is 1–2 inches high is of distinct advantage to give the plant close contact with moisture.

The London clay, with all its water problems, can produce profitable grass with little difficulty, provided the rules of good husbandry peculiar to heavy land are respected ; they can be simply expressed—when in doubt, keep out ! Wherever possible, reseeded clay land should be mole drained and, whether under-drained or not, consideration should be given to water furrows, according to the lie of the land.

Light Land All light lands have a common enemy in drought. There are several types of light land in Essex, and it is proposed to discuss the belts of valley gravel which fringe the London clay. This is a medium stony land where old pastures are a pathetic sight in a dry summer. Here, the one-year seeds figure in the rotation for hay, seed and sheep-feed

in spring and autumn. On the whole it is fair to say that broad red clover, trefoil and Italian ryegrass do tolerably well. The ryegrass period of growth coincides with the early summer hay requirement and spring and autumn sheep grazing, where the ley is destined for two years. It is the more permanent grass that gets into trouble, and that will remain the problem until leys containing types of grass that will withstand drought are introduced into the mixtures. Ryegrass can be introduced as temporary grazing for early and late season sheep-keep and can be sown at times to fit in with requirements. The indigenous grasses to be found in the permanent pastures will not stand up to conditions and provide midsummer keep : they should be replaced by cocksfoot-white clover and lucerne-cocksfoot. Although not so drought-resistant, the timothy-fescue-white clover pasture will make a good contribution, but the establishment of timothy appears difficult unless there is a good tilth. Only the deep-rooting plants can be expected to provide sufficient keep on these soils at times of the year when they are seriously affected by drought. The preparation of a fine, firm tilth on this light land presents little difficulty, but the acidity factor needs watching. With the gradual disappearance of hurdled sheep, it is essential for the light land occupiers to consider other means of maintaining fertility, and methods are found in the farming of lucerne and short-term leys to build up a clover-dominant sward to plough back.

Marsh Land The improvement of grassland on the coastal alluvial marshes of Essex is an entirely different matter from upland reseeding. First, one must picture a flat landscape, almost treeless and with very few fences. The boundaries of marshes are wide, deep ditches, with a fence here and there on either side of a drinking bay. In some areas a large part of the marshes is under arable cultivation and, although many are war arable areas, there is a large percentage which have been under the plough for many years. At one time cattle sheds were to be found in use far out into the marsh, and some provision for dung could be made for outlying arable. Today some of the buildings still stand but not so many cattle tread in straw, for the marshmen's cottages and some farmhouses stand empty and derelict. The fallow breaks into the rotation every four or five years and is frequently sown with mustard in preparation for wheat or barley. The Essex marsh farmer attaches considerable importance to the value of a good fallow, a sound sequence of crops, and a system to keep the land dry. As long as this husbandry is maintained with the wide range of crops that the marsh can grow, the land will go a long time before a rest in grass is needed. A break from the arable succession to act as a restorative crop can be provided by lucerne, which does very well on the marsh ; and crops of ryegrass and cocksfoot for seed are becoming popular.

In certain areas the marsh levels are very uneven, making it impossible to plough and difficult to surface-drain. Many acres where it has been possible to plough and reseed during the war face the same problems as those which have not had attention. Water for livestock is the problem. Pipe-laying across the marshes is very difficult because of the varying levels, and distance from the main supply makes it a costly job. In a dry year even the ditch reservoir, held through damming the ditches, gives out. The control of grazing is, therefore, difficult when gates must be left open for access to water. The average Essex marsh is predominantly bent with wild white clover and a fair proportion of crested dog's tail and some coarse cocksfoot. Where stock water remains a problem it will be difficult to prevent the reversion of new pastures, unless a sufficient head of stock can be carried. Whatever is said of the value of the types of grasses found on the marsh, they

must be credited with the provision of keep at a time when in dry weather the uplands are a sorry sight. Moreover, many marshes are capable of putting on flesh from a feed which does not appear promising, and it is probable that there is a lot which is not yet understood with regard to the properties of marsh grazing.

Many of the marshes have a common problem when ploughed. The dense matted turf, formed through undergrazing, can be constantly moved about, but the fibrous tufts survive several seasons. For direct reseeding after a short rotation, these tufts are still a hindrance for surface consolidation, which is difficult enough to obtain on the marsh without this added difficulty. The alluvial soils vary in texture. A suitable corn or root tilth can be obtained, but a first-class grass seed tilth is on occasions very difficult. In these cases the soil can be reduced to very small fragments, but a fine cohesive tilth is extremely difficult to secure. Whilst this fine texture is almost unobtainable, the union of the top few inches is nearly impossible. Where there is a high percentage of silt, water makes the surface greasy and frost appears to have very little effect. The most advantageous time to finalize a grass seedbed on this difficult type of alluvium is late in a summer fallow, when a fine tilth has been reduced to a point where it can no longer be improved and rain comes along to assist. As soon as the land is almost dry (this may be anything from 24 to 48 hours or more after several hours' fine rain), a disc and ring roll in tandem does make an improvement—but the " almost dry " condition should have careful consideration. On account of top surface consolidation difficulties, grasses and clovers are best drilled with the coulters set slightly deeper than is normally recommended on kinder soils, so as to ensure firm contact with moisture.

Some of the coastal grasslands can be reseeded successfully, but they have their problems. Many acres are impossible to plough and others are preferable left as they are. But they can be subjected to some improvement. The majority call for drastic harrowing to tear up the matt, which in turn allows penetration of lime, basic slag and nitrogen—treatment that would benefit many acres of this land. Some marshes are said to give no response to basic slag, but this may be yet another problem needing further investigation.

GRASSLAND IMPROVEMENT

A. S. Cray

Medstead, Alton, Hampshire

The following paper was read by Mr. A. S. Cray at a Grassland Conference in the Isle of Wight last year.

In talking about my practical experiences of grassland improvement, I may be expected to say, first, what was achieved, second, how it was done, and third, what lessons have been learnt in the doing. To do this it will be necessary to give an idea of the size, stocking, and general history of my farm. The land is clay with flints, typical Hampshire heavy land. It is fairly level but high (650-750 feet above sea level) and is rather exposed. The farm covers about 245 acres, of which I took 100 acres in July, 1940, a

further 120 acres in November, 1941, and the other 25 in 1947. This last 25 acres replaced another piece of about the same size which we had rented from 1942 until 1947.

All this land had been very much understocked for years, partly due no doubt to the thin times in the 'thirties, but in the main to lack of water. It was all exhausted and output was at a very low level. In the first two or three years failure to manure each crop liberally meant practically total loss.

Farm Policy Fertilizers were not so difficult to get in 1940 as they were later, but realizing they would get short I obtained all I could, especially phosphates When ploughing out exhausted land there is not much residual fertility on which to rely. The old turf helps tilth and provides some humus, but the lime, phosphates, potash and nitrogen have to come out of bags in the main. I believe it is quite possible to maintain fertility of a farm without livestock by the use of fertilizers and ploughing down green crops for humus, but it is not a method which appeals to me, and in any case I wanted to develop milk production.

On the other hand, it is useless to think that fertility will be built up, or even maintained, by just grazing with dairy cows. Like any other product that is sold off the farm, milk takes a good deal of plant food away, and that must be replaced from some outside source. It seemed clear that the only way to build up and maintain fertility on my exhausted land was to be very liberal with fertilizers to begin with and to grow food for all the stock we could possibly carry, so as to have plenty of dung going back to assist the building up. While exhausted turf ploughed down does not provide much fertility, a turf in good heart is another matter. Run-out turf will not provide much cow food either, so if fertility and production were to be pushed up, the ways of doing it seemed to be :

(1) Liberal use of fertilizers.
(2) Provision of water.
(3) Heaviest possible stocking.
(4) Ploughing out old turf.
(5) Putting down leys and ploughing out after a few years.

Development By and large that has been the programme of development. After a tussle we managed to get mains water in 1941 and have now been able to carry it all over the farm. Finding enough feed was the problem in the first couple of years. We came to the winter of 1941-42, for instance, with 70 head of stock and only 11 tons of hay, but during that year we made odd bits of silage from everything we could lay our hands on—rye and vetches, second-cut clover, autumn grass from a maiden ley, after-harvest growth from a one-year ley put down under wheat, and even old grass (mainly cocksfoot) cut in December on land taken over that November. That particular silage was very much better food than we expected. Of the 11 tons of hay, there were still 3 tons on March 31. It was at the end of that winter that we found the very great advantage of a new ley. Being high, we are very late in the spring, and old permanent pastures in our district show no grass worth speaking of until May. That spring of 1942 saw our dairy cows out on a good bite of ley grass on April 7. Since then we have never failed to get out to grass between April 5 and 14—until 1947: even after that terrible winter we went out on April 16, and that was on a fifth-year ley. It is difficult to estimate the value of that 2-3 weeks early grass ; as well as saving the cost of winter feeding at a most difficult period, the milk yield is probably 15-20 per cent higher.

By 1944 all the old turf was ploughed out, except for 27 acres which is unploughable. By 1945 we had between 120 and 130 head of stock, about 55 cows and the rest young stock, and we have had about 100 acres under corn each year. The house and buildings are at one end of the farm, but this year we are putting in a milking parlour at the other end, and we have enough heifers in calf to bring the milking herd up to about 90 ; 40 in the home buildings and 50 at the new plant. The herd is licensed T.T. and Attested, so we have to be self-contained and the general stocking is likely to be about 85-90 cows and 60 young stock. It is a high target but we feel pretty sure that improved grassland will make it possible.

The cropping this year is likely to be :

	acres
Wheat	13
Barley	7
Linseed	13
Oats	20
Oats and peas for silage (to be followed by rape and Hungry Gap kale)	25
Roots including 2 acres sugar beet	10
Permanent pasture	27
Ley, from maiden to 6th year	125

A fair acreage of ley has been ploughed out after two, three and four years, so that in the main we are on the second time round.

Whilst the land is under the plough the usual range of crops is grown wheat, barley, linseed, oats, mangolds, kale and a few potatoes. Sugar beet is a new venture. Spring oats and peas for silage are cut in sheaves with the binder and made in a stack like an ordinary corn stack, and it comes in very useful as winter feed for young cattle. Provided the stacks are not too small, the method works very well indeed, and apart from the feed it provides, this crop fits in with a number of possibilities. It can be followed by a bastard fallow for cleaning, by another crop such as marrow-stem kale (transplanted), rape for feed in the autumn, Hungry Gap kale for use in March, and mustard for ploughing in. It is one of the best of nurse crops for grass seeds.

Measure of Improvement I should now produce some evidence of the measure of the increased yield obtained from improved grassland. The details of stock carried that I have given already are a fairly good guide, but to have something more definite to satisfy myself I recorded all of my grazing and grassland production most carefully throughout 1944. I found that a bit of old pasture left very much in its original condition (and it is fairly typical of the district) gave 70-80 cow-grazing days per acre, old pasture improved gave about 140, leys not at their best about 220-250, and the best leys well over 300. It is a moderate statement to say that reseeding, coupled with suitable management, has trebled production on my land, and probably the same is possible with most of the low-yielding grassland up and down the country. When it is considered that grass is a perennial crop and that one lot of seeds and one lot of cultivation covers a period of several years, the value of improved grasses on the stock farm is beyond question.

Our first step was to dress all the old permanent pasture with 45 cwt. of ground chalk and 10 cwt. basic slag to the acre, and harrow two, three or four times. This improves the grass, brings on the white clover, and in cases where we ploughed out a year after such treatment, the corn crops have been very good indeed. Suitably adjusted to meet local circumstances and soil deficiencies, I think that this kind of treatment cannot fail to benefit

any neglected grassland which for one reason or another cannot be ploughed out for a year or two.

Methods of Seeding With nearly the whole farm to tackle, it was necessary to sow down in several ways: by reseeding direct on ploughed-out turf, and by undersowing wheat, barley and spring oats. But oats and peas for silage has proved the best nurse crop. The method is to drill and harrow in the oat-and-pea mixture in the ordinary way, roll with the ring roller, then broadcast the grass seed and harrow and roll by using a set of very light seed harrows under the drawbar of the roller. We have found that the grass seed gets a good start before there is any smothering effect from the nurse crop. The oat and pea crop is cut in late June or early July, and any young grass cut with it is a useful ingredient of the silage mixture instead of a serious nuisance, as it can be in a corn crop in a damp season. After cutting, the seeds romp ahead; a light dressing of nitrogen helps. By early- or mid-August, according to the weather, there is a good bite of grass, followed by another a month or so later. Apart from the value of the keep, the treading given to the land under favourable conditions brings about a particularly good establishment. The field is, of course, treated leniently in the autumn, and we have always had very early grass and very high production in the following year. The amount of grass taken after the silage crop in the seeding year is likely to be at least as much as we should get from permanent pasture in a full year. Judging by our experience with direct reseeding on ploughed turf, seeding without any sort of nurse crop is likely to give the best result of all, and I am determined to try and put down at least one piece of seeds by this method every year. Quite apart from the best establishment of the seeds, the maiden grass grows on during the summer when other grass has slowed down, and it is very useful to give feed and keep up the milk at a difficult time. My own experience leads me to believe that the order of merit of the various methods of seeding is:

(1) Without a nurse crop
(2) Under a forage nurse crop
(3) Under a cereal nurse crop

but we have had perfectly satisfactory takes by all methods.

Drilling and Broadcasting Seeds The general opinion seems to be in favour of drilling grass seeds, and the theory of it seems to be perfectly sound. It has always seemed to me that there must be an enormous wastage of seed when it is broadcast. The drill puts the seed down underneath where it is likely to have moisture and get the best chance of germination. Even so, all our earlier leys were broadcast so successfully that we hesitated to go over entirely to a new method. Up to date we have used the drill on two separate leys but I have, of course, seen plenty of leys on other farms where the seeds have been drilled. I am left with the impression that where the tilth conditions are good and there is no grave likelihood of the seeds being killed by drying out, broadcasting is preferable to drilling with a corn drill having 7-inch coulter spacings. If I had a 4-inch drill I should probably drill in preference to broadcasting. Either method, I think, is likely to be successful provided the cultivations and conditions are right.

Cultivations I am certain that it is worth going to a good deal of trouble to get conditions as nearly right as possible. The land needs to be very firm, with a good fine tilth. It is important to keep all the moisture possible underneath, and in this connection a frost tilth is very valuable; the land does not need to be worked about and dried out in the

process. If seeds are being sown under winter wheat there is usually plenty of consolidation of our land and the difficulty is to work up a tilth on top. We have found that drastic harrowing does not hurt the wheat at all and on occasions, when the land has been beaten down by rain and become set, we have had to get ripper harrows to work. With spring corn I think it is a very great advantage to put down the grass seeds at the same time as the corn is drilled. It probably means more grass in the butts of the sheaves at harvest time, but that is better than a poor take.

In a bad season it is worth while to move the corn shocks rather than let them stand too long in one place and kill out the grass. Leaving a long stubble helps, as it means less grass in the butts and more air in the shocks ; the long stubble helps to keep the sheaves well up off the ground.

Manuring Manuring is of the highest importance, lime and phosphates are probably the most important fertilizers, but when the seeds are sown under corn it is essential that the manuring should not be so heavy as to make the corn go down. Nothing kills out seeds more quickly than laid corn. One great advantage of seeding without a cover crop, or with a crop that is to be cut green, is that the amount of manure can be adequate without fear of laid crops. We have done a good deal of seeding for neighbours who have no tackle of their own. Although the same methods and the same seed mixtures were used, a considerable number of those have given very poor results, particularly with the clovers. I consider this has been nearly always due to lack of fertilizers, particularly lime and phosphates.

Seeds Mixtures We have done a fair amount of experimenting with seeds mixtures and have tried to make comparisons between the pedigree and commercial strains of seeds. I have one field that was put down with a general-purpose mixture. One-third was sown with pedigree seeds, another third commercial seeds, and the other strip a half-and-half mixture of pedigree and commercial. This ley is now coming into its fourth harvest year. The commercial strip comes away earliest in the spring and the pedigree latest. The commercial strip runs up to seed rather more quickly and, as far as I can see at the present time, moss is coming in pretty rapidly. This year I think we shall have evidence that the commercial seeds are not so persistent as the pedigree.

In another field we put down a simple ryegrass-white clover mixture. One plot had commercial ryegrass and English wild white clover, the second had New Zealand Hawkes Bay ryegrass and New Zealand white clover, whilst the third had S.23 pedigree ryegrass with S.100 white clover. That ley stayed down for three years but is being ploughed up this winter. The Hawkes Bay ryegrass runs up to stalk very quickly and seems to be unpalatable unless it is grazed at a very early stage. As soon as it begins to run up to stalk the cattle leave it if there is anything else available. The commercial ryegrass has practically disappeared. The S.23 ryegrass is not as early as either of the others and was not as productive in the first year, but last year it was undoubtedly the best of the three. Having seen these perennial ryegrass strains growing side by side, I have come to the conclusion that the New Zealand Hawkes Bay serves no useful purpose. The commercial is valuable for earliness and more bulk in the first year or so, and S.23 is considerably more persistent. This is all in line with what we have been told by the experts, and I think there is a lot to be said for using part commercial and part pedigree in a mixture, although many people prefer all pedigree grasses. What I have said applies in particular to ryegrass and,

whilst it may not be true to quite the same extent of some of the other grasses, I think it would be a fairly safe practice for anybody without much experience to use part pedigree and part commercial.

Of the white clovers, the English wild white is very persistent in dry weather but does not give much bulk. There is not very much to choose between New Zealand and the S.100 ; the New Zealand is a very strong starter in the spring but the S.100 is rather more bulky. I think the New Zealand has the additional advantage on my land of being rather better in the first harvest year, but the S.100 is probably better over several years. This year I shall be using 1 lb. of S.100, ½ lb. New Zealand, and ½ lb. English wild white. In any ley not expected to stay down more than three years I should put 1 lb. S.100 and 1 lb. New Zealand.

In the main we have used general-purpose mixtures. They are very safe and there is not quite so much risk of a serious check in production if the management is not quite all that it should be. We are trying out special-purpose seedings gradually to see exactly how they fit in. In 1947, we had a cocksfoot ley in its harvest year, and it certainly showed to advantage during the severe drought. This year we are putting down another, but I think we must be careful not to get more cocksfoot leys than we can keep under strict control. Cocksfoot is very deep rooting and no doubt it stands drought and treading better than some other grasses. It is good for early bite and for early cutting either as silage or hay. It then grows away very well to provide keep during midsummer or early July, but it needs careful management.

This year we are putting down timothy/meadow fescue ley for the first time for late autumn keep and also as a reserve for summer feed. Timothy seems to keep leafy for longer than the other grasses and to be useful fairly late in the spring or early summer if keep should get short. The general-purpose mixtures we have used generally had about 12 lb. perennial ryegrass, 8 lb. cocksfoot, 8 lb. timothy, 2 lb. late-flowering red clover, 2 lb. white clover —32 lb. in all. This year we are reducing to about 26 lb., the ryegrass being cut to 8 lb., with no late-flowering red clover. I am very interested in the arguments for a very much lighter seeding rate and I am trying out one ley to be put down this year. Here again it is a case of not moving away too quickly from the heavier seeding rates which have given us such very good results in the past.

For the last two years I have not bothered with a ryegrass/broad red clover one-year ley for hay. We had one or two each year for several years but we never seemed to avoid a good deal of loss of clover leaf by the time the hay got into the cribs. I feel that a general-purpose mixture is likely to do all that a one-year ley will do and be much more flexible.

Management :
ROTATION OF TREATMENT

I try to base my management on the following broad principles. First I try to vary treatment of each ley from year to year so that each of the different types of grass gets a period of hard usage followed by a period of more lenient treatment to give it a chance to recover. This is necessary if a fair balance between grasses and clovers, early grasses and late grasses is to be maintained.

Early bite, for instance, will punish cocksfoot and ryegrass, thus it is better not to use the same field for early bite two years running. Letting a field stand for hay will punish clovers because of the overshadowing during the normal clover growth period, but grazing hard during the spring and then resting the field during June will strengthen the clovers considerably. The late summer is a very good time for resting any of the grasses, since they will

grow a very strong leaf system without running up seed stalks and heads nearly as much as they do in the spring. Autumn resting of the grasses gives them a chance to build up strength in readiness for early and strong spring growth.

"ON-AND-OFF" GRAZING My second principle is "on-and-off" grazing. This is really a variation of No. 1, since this feature is based on the fact that leaf development and root development run together very closely. When the plant is allowed to grow and develop a good leaf system, it also develops a strong root system and then when the grass is grazed there is a good supply of plant food stored up in readiness for a new growth When fields are grazed continuously the plant never gets a strong leaf and consequently the roots get weaker and weaker Eventually the plants get dwarfed and die out. In practice I have found that during the spring and early summer 40-50 cows must not have more than 7 or 8 acres at a time. If they do the grass grows to them and the field is grazed unevenly. Some of it is grazed tightly the whole time, other parts will be left alone and will get overgrown and rank. During spring a 7- or 8-acre plot will take the cows for anything from 6 to 14 days, according to rate of growth and the amount of grass when they go in. We do not graze down too tightly as we think that the grass is slower getting away again afterwards, and of course cows in full milk cannot get sufficient feed if the grass gets too short. Under British conditions a field will probably grow more grass in the whole season if it is not grazed too tightly every time the cattle are in. The important point to remember is that the feeding value is at its highest when the grasses are in the leafy stage, and it begins to drop very rapidly when the grass runs up to stem and seed heads begin to form. As far as grazing is concerned, clearly it is good sense to graze before feeding value begins to fall off; and when it comes to conservation for winter use the point is of greater importance still.

FERTILITY LEVEL The next thing to bear in mind the whole time is the need to maintain a high fertility. The most productive grasses do best and last longest under conditions of high fertility. Whilst it is true that the clovers will collect a considerable amount of nitrogen from the air, it is not reasonable to expect too much for nothing, and as productive grasses are likely to produce more animal food to the acre than practically any other crop, it is necessary and profitable to fertilize appropriately.

We are basing our manuring on the likelihood of the grassland requiring 4 or 5 cwt. of slag and 1 cwt. muriate of potash each year, with anything from 1-3 cwt. of sulphate of ammonia per acre, according to circumstances. It goes without saying that the lime status must be maintained. Lime and phosphates are without doubt the most important of grassland fertilizers. Granted these, the clovers will do well with reasonable management and in turn will get the maximum amount of nitrogen from the atmosphere.

I am quite sure that everybody who has a serious shot at improving his grassland will go on with it, and it is certainly not essential to start in a big way. Start with one or two fields, feel your way and you will certainly be encouraged by the results you get. Ploughing out every few years may be desirable where it can be done conveniently, but there is plenty of scope for increased output on fields where it is not possible. Liberal fertilizing and careful management pay big dividends.

BREEDING STRAWBERRIES FOR DISEASE RESISTANCE

R. D. REID
Department of Agriculture for Scotland
at The West of Scotland Agricultural College, Auchincruive

DURING the past thirty years there has been a serious decline in the acreage under strawberries in Great Britain. Apart from economic conditions, especially the shortage of casual labour, which have contributed to keeping the acreage at a low level, the crop has to contend with a number of diseases and pests which may kill the plants outright, or reduce the crop seriously.

The main troubles responsible for the present difficulties are those caused by the root rots, virus diseases, and by the bud eelworm. The root rots may be cortical, i.e., affecting the cortex or outer portion of the roots, and while they are associated with a number of different soil fungi, they are generally the result of unsatisfactory soil conditions. Much work has been done on this problem by Berkeley and other workers in Canada.

The most serious form of root rot is that affecting the stele or vascular system of the root which is destroyed by the fungus *Phytophthora fragariae*. This disease was first recorded in the Clyde Valley, and for some time was known as " Lanarkshire " disease. Because of the typical reddish-brown discoloration of the central portion, or stele, of the affected root, it was named " Red Core " disease ; in America, where it is now one of the biggest problems in strawberry growing, it is known as " Red Stele " disease. Whole plantations can be completely destroyed by this disease in a very short time. It can exist and do serious damage in almost any type of soil, but it is always much worse where the soil is very wet and in areas which have a high winter rainfall. Apart from badly-drained soils, its intensity varies in relation to the number of days on which rain actually falls. In the most severely affected districts in the west of Scotland, during the six months October to March (182 days) rain may fall on 90 to 130 days. At the lower figure damage is not usually marked, but in years where the higher figure is approached, loss from Red Core is likely to be heavy wherever infection is present.

It seems probable also that low summer soil temperatures favour the maximum development of the disease. In lighter, well-drained soils, especially in the east of the country where the winter rainfall is lower, Red Core disease is not quite so widespread and reaches its maximum intensity only in years when the winter rainfall is above the average.

There is considerable variation in varietal resistance to the disease, ranging from extreme susceptibility to almost complete immunity. Certain varieties may be classed as fairly resistant if grown in the drier parts of the country, but the same varieties may rapidly succumb if grown in other areas. In the south-west of Scotland none of the older varieties can now be grown on heavily infected soil. The most encouraging approach to the control of Red Core is in the production of resistant varieties. Extensive breeding with this objective is being carried out in the U.S.A., in Canada, and in this country. This article is a brief review of the work on which the writer has been primarily engaged at Auchincruive. In the execution of the work, however, strawberry eelworm and the virus diseases have impinged so markedly that at times they have threatened to submerge the main issue. In consequence the methods of working have frequently had to be modified and additional work undertaken in order to correlate the breeding work with the control of the other diseases. In particular, their presence

calls for special methods of propagation and special testing of seedlings selected for trial. It is desirable, therefore, to give a brief account of the nature of these diseases before discussing the breeding work more fully.

Strawberry Eelworm A wide range of symptoms involving malformation of leaves and crowns has at various times been associated with various species of nematodes, particularly the strawberry bud eelworm, *Aphelenchoides fragariae*. Different names descriptive of the symptoms have been applied, including Cauliflower Disease, Red Plant, Spring Dwarf, Summer Dwarf, Crimp, etc. It is now believed that all these abnormalities are due to infection with various species of eelworms, the range of symptoms varying according to severity of infection, the stage of growth when damage is done, and other factors not yet fully known. Experiments carried out at Auchincruive have shown that inoculation with *A. fragariae* can reproduce the symptoms known as " Spring Dwarf," and observations suggest that all the groups of symptoms are closely related. The Spring Dwarf stage shows a range of malformations affecting the crown and lamina. Leaves show varying types of malformation and crimping which in many cases superficially resemble those caused by the virus disease Crinkle. A noticeable feature is that the leaf serrations are usually abnormal, ranging from almost complete absence to grossly accentuated serrations. Severely affected plants may be completely barren, but usually there is a partial recovery, resulting in the production of later trusses from modified stolon buds. Such plants carry a reduced crop, and this partial recovery is often the cause of the trouble being overlooked.

The general effect of this pest is to reduce the crop considerably rather than to destroy the plantation completely, and it is believed that the well-known great variation in the cropping capacity of different " strains " of certain varieties may be due to the incidence of this pest. Normally the maximum symptoms are apparent from about the middle of April until the middle of May, when the leaves emerging from the buds which have been damaged throughout the winter show a wide range of malformation. Towards the end of May more normal leaves appear from later buds, and symptoms usually become masked during the summer months. There is usually a reappearance of symptoms about September.

The chief means of spreading the eelworm is by planting runners from infected plants, since all stolons produced from affected plants usually carry the nematodes in their growing points. In the present state of knowledge the only effective control is by selection of healthy plants for propagation. The recognition of symptoms in selection of plants is considerably influenced by the date of planting. Since symptoms are usually most apparent at the end of April and again in September, it follows that early planting, so desirable for other reasons, may result in the propagation of infected plants at a time when symptoms have not developed or are masked. Where strawberry eelworm is suspected it may be advisable to delay planting so that more care can be given to the selection of healthy propagation stock.

Virus Diseases The virus diseases, generally called Yellow Edge and Crinkle, have been studied by various workers, especially at East Malling Research Station and at Bangor. It has been shown that a number of different viruses can be found in diseased strawberry plants either singly or in different combinations and that the symptom picture varies with the particular complex of viruses present. Moreover, varieties differ considerably in their reaction to the different viruses. Some varieties, such as Royal Sovereign, are apparently "sensitive" to all the viruses and show foliage symptoms when infected by any single virus or group. Other varieties,

of which the best known is Huxley Giant, are " tolerant " of some viruses, which they can carry without themselves showing serious symptoms, but they may also develop acute symptoms when infected by particular combinations of viruses. Symptoms may vary from slight spotting of the leaves to extreme dwarfing, localized or general yellowing of foliage, and failure to crop. Under experimental conditions virus infection can be transferred to a healthy " indicator " plant by stolon grafting, but under natural conditions the only means of spread seems to be by the strawberry aphis, *Capitophorus fragariae*. If this is present it is dangerous to grow different varieties close together, since a " tolerant " carrier may easily serve as a source of infection to a " sensitive". It is important, therefore, in breeding new varieties to know if a new variety is tolerant or sensitive. Control of the virus diseases lies in the cultivation of " virus-free " stocks, keeping down the aphis population and avoiding mixing types.

Breeding for Resistance to Red Core The Red Core root rot was first recorded in the Clyde Valley in 1921, and it spread with such rapidity that in a comparatively short time the area under strawberries had fallen to about 20 per cent of the pre-1914 acreage. Early work by Howells, Alcock and Foister showed the general nature of the disease, and later other workers confirmed its presence in other districts. It is now known to be present in almost all counties in Scotland, and in very many districts of England. It is also known to exist in France and to assume serious proportions in Northern Ireland, Eire, U.S.A., Canada, and New Zealand.

Early work by Howells and his colleagues explored very fully the possibility of controlling the disease by modifications of cultural methods, by the use of a wide range of soil fungicides, and by numerous modifications of nutritional and physical treatments of the soil. It was eventually decided that the only line of approach giving any promise of success was by the production of highly resistant varieties, and in 1933 the writer, who had been closely associated with the early workers for some years, started systematic breeding work at Auchincruive.

Since the inception of this work, over 550 families of seedlings have been raised; these produced over 40,000 seedlings, and the work is being continued. Crossing is carried out in a glasshouse and the seedlings, when big enough to handle, are pricked out into boxes infected with soil taken from diseased fields. Seedlings which become infected are discarded and the survivors then planted out in infected soil and allowed to grow for about two years.

In the first winter after planting out, large numbers develop symptoms. These are discarded and the remainder fruited as single plant units. Any which give promise of reasonably good fruiting habits are propagated in four-plant units (squares 1 yard apart), again in infected soil, where they are grown for two years. Throughout this period seedlings which show infection with Red Core or other diseases are discarded, and eventually those which over a period of years show promise of high resistance combined with good fruiting qualities are propagated and tested on a more extensive scale.

In the work hitherto it has been the practice that when a selection reached the stage of justifying its development, stocks were split, a portion being continued in infected soil on a number of different farms in order to ensure maximum exposure to infection, so testing resistance as thoroughly as possible. The rest of the runners of the selection have been propagated for several years on new land so as to avoid the risk of sending out plants with infected soil adhering to the roots. Samples of plants have usually been submitted to East Malling Research Station for virus test, and to other

centres for fruiting trials. Future plans aim at a more thorough policy of testing and propagation by raising such stocks as are eventually to be distributed from a single-tested virus-free plant. The wider distribution now being demanded of any new introduction and the rapid deterioration which experience has shown to accompany indiscriminate propagation make this procedure desirable.

The early scope of the work was simply to meet an urgent local problem and to provide varieties which would grow on the local heavily infected land where all other varieties failed. Interest in the work is now evident from a much wider area, and it is necessary to arrange testing on a larger scale and to set a higher standard of suitability of fruit for a wider range of conditions.

The difficulties involved in the breeding programme seem almost insuperable. The relatively few really good varieties of strawberry produced during the last hundred years show that from the fruit production angle alone new worthwhile varieties are not easy to produce. When resistance to a major disease is the primary consideration it inevitably means discarding enormous numbers of potentially useful fruiting varieties, some of which might well have proved equal in value to commercial varieties in present or past cultivation.

It seems probable that there is no absolute line of demarcation between susceptibility and immunity, but there is a widely varying range of susceptibility; Madame Lefebvre is generally considered the most susceptible, while Oberschlesien and Pillnitz are probably the most resistant of the older varieties. Once a field has become infected, none of the known varieties is commercially resistant in the climatic and soil conditions prevailing in the west of Scotland. Varieties from all over the world were therefore tested in order to find a source of resistance for breeding purposes. The first promising line was a selection from what was believed to be the variety Frith which was grown under its plot number, "52", its identity never being fully established and the original stock being infected with Yellow Edge. At a later period, thanks to the collaboration of Dr. H. W. Anderson of Illinois, the American variety Aberdeen was found to be the most highly resistant variety. The earlier successful seedlings were raised from No. 52 and later, by combining this source with Aberdeen, very encouraging results were obtained.

The proportion of seedlings showing resistance in the first year of test varies from season to season, according to the weather. Moreover, a diminishing proportion of those which resist infection in the first year become infected in later years. The general behaviour of the families in their first year in infected soil, however, gives a good indication of the relative merits of different crosses. Families of seedlings raised from susceptible parents may show 90 to 100 per cent infection in the first year, while families raised by crossing two very highly resistant parents, when tested under identical conditions, may show less than 25 per cent infection. Resistance appears to be a dominant factor, since susceptible seedlings, even if bred from resistant parents, in their turn only produce susceptibles. It is usually found that the most highly resistant varieties may prove completely resistant when tested under the most severe conditions it is possible to devise, for periods up to eight years and on a variety of farms, but that, when released into commerce and grown on hundreds of farms, the disease may appear occasionally. American workers report a similar experience.

The nature of this "breakdown" in resistance is not yet certain. Judging from the experience of others who have attempted breeding varieties of plants resistant to diseases, notably Potato Blight and Tomato Leaf Mould, the most usual cause of such loss of resistance is the production of new

strains of the pathogen. The possibility of this occurring with resistant varieties of strawberries is at present being investigated by Dr. C. J. Hickman of Birmingham University, who is collaborating in this work. While this explanation is the most probable, the environmental relationships cannot be overlooked, since such isolated cases of disease as occur amongst otherwise highly resistant varieties are almost invariably in localized areas where environmental conditions are most favourable to the pathogen and unfavourable to the plant. In practice it is found that despite occasional incidence of disease amongst these highly resistant varieties, their introduction has made it possible once again to grow strawberries on land where this crop has invariably failed during the last twenty years when ordinary varieties have been planted.

Auchincruive Varieties The following is the position regarding the "Auchincruive" varieties released up to the present. In 1938 some selections were distributed for extensive trials amongst growers in Lanarkshire having heavily infected land. By 1940 these were being grown by about seventy growers, many of whom had extended the area planted to several acres. In 1941 it was decided to release the best of these stocks free from all restrictions, and instead of being named they were allowed to retain the numbers under which they had been tested, namely, Auchincruive 1, 2, 4, 5, and 6. By 1941 very infrequently small patches of disease appeared, but they were rarely serious. At the present time these varieties are still the mainstay of the industry in that part of the south-west of Scotland where Red Core disease had practically destroyed the industry. At the time of their release it was fully realized and made clear that these plants were to be regarded only as temporary introductions to meet an urgent local need, and that they would be replaced as better varieties became available. Intended for this local need, they have not been distributed appreciably outside the infected areas of Clydeside, and the provisions of the Scottish Certification Scheme, which does not accept for inspection any land with a history of Red Core disease, make their rapid distribution improbable. The varieties which have proved most popular are No. 1, 5 and 6, the last probably being most widely grown at present. These varieties are very highly resistant to Red Core disease, sensitive to virus diseases and normally good croppers ; the fruit has good colour, shape and flavour, but the soft texture results in rotting in damp situations or in wet seasons, and they do not carry well. They make excellent jam but the fruit breaks up in manufacture.

The next introduction in 1945 was not given a name, but simply retained its breeding number of LR 19. It does not possess any special degree of resistance to Red Core disease and it is sensitive to virus diseases of the Yellow Edge type. However, it set a very high standard of cropping and quality of fruit and gave promise of being a very useful first early for non-infected areas. No special efforts were made to give it widespread distribution, and most of the growers handling it did not attempt to isolate it ; nor did they confine it to uninfected land, and the vigour of most stocks degenerated rapidly. Some growers, however, have been extremely successful with this variety, and it is probable that more may yet be heard of it since some of the present growers wish to develop it and have asked that it be renamed.

The most recent introduction has been Auchincruive Climax, which was released in April, 1947. This is a late maincrop variety, a very strong grower and free cropper. The fruit is very large, size being well maintained throughout the season. The colour of the fruit is dark crimson and the flesh is tinged

throughout. The texture is very good and the flavour excellent. This variety was given the Award of Merit by the Royal Horticultural Society in 1948. Reports from a commercial jam manufacturer have been very favourable. Apart from any question of disease resistance, this variety promises to be a useful acquisition to the trade. It was raised in 1939 as a result of crossing the American variety Aberdeen with a third generation seedling from No. 52. It was tested under the most rigid conditions that could be devised for Red Core resistance over eight years, and up to the spring of 1948 no infection had been seen. During the past few months, however, a very few cases of infection have been seen, under conditions, and in a season, which have resulted in the disease being generally worse than the average. Most plantations which have been examined show that resistance is being well maintained and in some cases the contrast between this variety and a recognized susceptible variety is quite spectacular.

Over 400 growers have been supplied from the central station and considerable secondary distribution from growers took place in 1948. It has not been possible to obtain reports from all growers but, as was only to be expected, there have been a few reports of dissatisfaction. The normally dark foliage of this variety seems to respond to any abnormality by becoming conspicuously light in colour. Cases of yellowing and dwarfing of individual plants have on several occasions been found to be caused by tarsonemid mite. Possibly the most prevalent trouble in practically all strawberry plantations at the present time is the " Spring Dwarf " caused by the strawberry eelworm, and this variety, like all others, has not escaped occasional infection. The whole story of its reactions to the various possible virus complexes has not yet been fully worked out. Tests have shown that the main stock from which all original distribution took place was almost completely virus-free. Artificial infections made by the virus specialists at East Malling Research Station produced no foliage symptoms from the complex which normally produces Yellow Edge in Huxley Giant, and it was believed that Auchincruive Climax was super-tolerant. However, observations during the past season have shown that when exposed to certain virus infections it can develop acute symptoms. This effect has been specially noted on plants growing in the immediate vicinity of Royal Sovereign in the most advanced stages of virus degeneration. These effects and other possible virus reactions are at present being studied by the virus specialists. Meantime special stocks of Auchincruive Climax have been raised from single-tested virus-free plants at East Malling Research Station and at Auchincruive. The East Malling stock is now being distributed.

One other factor has caused a certain amount of uneasiness amongst a few growers. In some cases it has been noticed that second-year plants, growing very vigorously and carrying a heavy crop of fruit, have shown some degree of chlorosis when a large number of berries are on the point of ripening. This effect is usually rapidly outgrown immediately the crop is off, and it is believed to be a nutritional question. The Macaulay Institute for Soil Research is carrying out experiments in strawberry nutrition with this variety, and their experiments should do much to clear up some points about nutrition of which very little is known at present.

Different Types for Different Districts

The breeding work at Auchincruive is being continued and, as far as possible, extended. There exists at present a large pool of seedlings amongst which there are hundreds of promising selections. Rigorous tests applied over a number of years will result in discarding all but a few. It is not intended to put any large quantity of new varieties on the market, but it is hoped that one new variety will become available every

few years, and that these shall as far as possible be of different types and possibly suited to different districts. Climax is considered too late for certain districts, and it is hoped that the next introduction may be a much earlier ripening variety.

In a country such as this where there are so many local variations in soil and climate and in consumer demand, there is room for a number of varieties, none of which can be expected to be universally popular but each of which may be adopted as most suitable for a particular locality or trade. The relationship to Red Core disease will, however, continue to be the dominant feature of the breeding programme.

This work has been financed by the Development Commissioners on the recommendation of the Agricultural Research Council and has been carried out by the Department of Agriculture for Scotland, the West of Scotland Agricultural College kindly providing land and other facilities. Grateful thanks are extended to all who have assisted in many ways.

Bibliography

1. ALCOCK, N. L. (MRS.), HOWELLS, D. V. and FOISTER, C. E. Strawberry Disease in Lanarkshire. *Scot. J. Agric.* (1930) **13**, 242.
2. BERKELEY, G. H. and LAUDER-THOMSON, I. *J. Pomol.* (1934) **12**, 3, 226.
3. WEST, P. M. and HILDEBRAND, A. A. Strawberry Root Rot in relation to Microbiological Changes induced in Root Rot Soil by the Incorporation of Certain Cover Crops. *Canadian J. Res.* (1941) **C. 19**, 183.
4. WEST, P. M. and HILDEBRAND, A. A. The Microbiological Balance of Strawberry Root Rot Soil as Relation to the Rhizosphere and Decomposition Effects of Certain Cover Crops. *Canadian J. Res.* (1941) **C. 19**, 199.
5. HICKMAN, C. J. The Red Core Root Disease of Strawberry caused by Phytophthora fragariae. n. sp. *J. Pomol.* (1940) **18**, 89.
6. ANDERSON, H. W. Red Stele Root Rot of the Strawberry. Report from *Trans. of Illinois State Hort. Soc.* (1940) **74**, 383.
7. BAIN, HENRY F. and DEMAREE, J. B. Red Stele Root Disease of the Strawberry caused by Phytophthora fragariae. *J. Agric. Res.* (1945) **70**, 1, 11.
8. WALDO, G. F., DARROW, G. M., *et al.* Breeding Strawberries for Resistance to Red) Stele Root Disease. *Trans. Peninsul. Hort. Soc.* (1946) 22.
9. REID, R. D. Red Core Disease of the Strawberry. *Scot. J. Agric.* (1941) **23**, 3.
10. REID, R. D. Strawberry Red Core Disease: A Progress Report. *Fruit Grower* (1944) **97**, 2508, 9, and 2509, 20.
11. REID, R. D. Strawberry Breeding at Auchincruive. *Scot. Agric.* (1948) **27**, 4.
12. HARRIS, R. V. The Strawberry "Yellow Edge" Disease. *J. Pomol.* (1933) **11**, 1, 56.
13. PRENTICE, I. W. Resolution and Synthesis of virus Complexes Causing Strawberry Yellow Edge. *Nature* (1946) **148**, 24.
14. PRENTICE, I. W. and HARRIS, R. V. Resolution of Strawberry Virus Complexes by means of the Aphis Vector Capitophorus fragariae Theob. *Ann. Appl. Biol.* (1946) **33**, 1, 50.
15. WOOD, C. A. and WHITEHEAD, T. Etiology of Strawberry Virus Diseases. *Nature* (1947) **160**, 4074, 761.
16. ORMEROD, E. A. Attack of Eelworms in Strawberry Plantations in Kent. *Orchard and Bush Fruit Insects* (1898) 251.
17. RITZEMA BOS, J. *Maanblad Voor Naturwe Enschlappen* (Jaargang 1889) **7**.
18. BROOKS, A. N. "Crimp"—A Nematode Disease of Strawberry. *Florida Agric. Exp. Bull.* (1931) 235.
19. OGILVIE, Laurence. A Strawberry Disease Resembling the American 'Crimp'. *Ann. Rep. Agric. and Hort. Res. Sta., Long Ashton* (1935) 76.
20. GOODEY, T. *Plant Parasitic Nematodes* (1933) 193.
21. LEES, A. H., STANILAND, L. N., BALL, E., *et al.* *Ann. Rpts. Agric. and Hort. Res. Sta., Long Ashton* (1924, 1925, 1927, 1928).
22. CHRISTIE, J. R. Spring Dwarf and Summer Dwarf of Strawberries. *Circ. No.* **681**, *United States Dept. of Agric. Washington, D.C.* (1943).

DANISH FARMING

D. E. Tribe, B.Sc. (Agric.)

The Rowett Research Institute, Bucksburn, Aberdeen

Mr. Tribe visited Denmark on a Ministry of Agriculture post-graduate scholarship in 1947. He here records the impressions with which he came away.

THE basis of agricultural production in Denmark is the family farm, where the owner takes his part as active manager, and he and members of his family perform most of the work. Of the total labour force, however, 41 per cent is hired; this is due to the intensity of production and overall low mechanization. Some 48.8 per cent of farms are less than 25 acres in size, and the average size is only 43 acres.

Denmark's economic, political, and population conditions, together with her mild climate, and soil consisting mainly of moraine clay and sand, have combined to determine that her characteristic farming system shall be a pronounced mixed husbandry, with livestock, and livestock produce, as the ultimate aim. In 1944, 74.2 per cent of the industry's gross income came from animal production. This actually shows a decrease of 10 per cent on the 1938 figure, due to the restricted imports of cereals, etc. during the war and the consequent necessity of increasing the home crop production. The regional variations of this system, with the exception of Lolland-Falster, which specializes in marketable crops, are only slight, but the variations due to size of farm are significant; 40.1 per cent of the gross income on farms of over 250 acres was, in 1944, obtained from crop production, while only 9.5 per cent was obtained on holdings under 25 acres.

Denmark's 1,578 thousand milk cows* represent the backbone of the agricultural, and to a large extent, the whole national, economy. The importance of the dairying industry cannot be over-emphasized, but it should be borne in mind that the pig industry is associated closely with it. Poultry-keeping is also of great importance and provides an excellent means of utilizing to the full the considerable amount of labour needed in milk production on the larger farms, and the semi-domestic labour available on the smaller farms. There are no farms which may be described as dairy farms, pig farms, or poultry farms; the system is truly mixed but adequate opportunity is given for specialization and enterprise in any one direction should economic or political changes so demand. The only type of farm which may be described as highly specialized is the fur farm, and of this mention will be made later. Sheep are of negligible importance in this intensive economy, but horses are still valuable sources of power.

I was deeply impressed by the fact that while Denmark is not only self-supporting in beef but even exports it to other western European countries, there is not a single purely beef animal in the country. With the exception of a few Black and White Jutland, Dairy Shorthorn, and Channel Island herds, the great majority (70 per cent) of the cattle are of the Red Danish breed, which is described as "definitely single-purpose". All with whom I raised the matter assured me of their dislike for anything claiming to be of a dual-purpose nature.

Small Farms Since the passing in 1899 of the first Danish Land Settlement Act, which made State subsidy available for the establishment of small holdings, similar legislation has resulted in the establishment of 24,948 new holdings, the extension of 14,927 holdings, and a total expenditure by the State of 281 million kroner in loans. The

* Since dropped to approximately 1½ millions.

average size of these holdings is 25–30 acres. A vivid social agricultural policy has thus characterized Danish legislation for many years and laid the foundations of the present agricultural system.

Most impressive of the several merits of the smallholder is the extent of his personal knowledge and his serene and enthusiastic (though perhaps restricted) outlook. His education has given him a sound and broad foundation on which he is able to build by using the facilities, provided by the Cooperative Societies, the Savings Banks, and the Danish Land Credit System, for credit and loans.

The farmsteads are painted once each year, and give the appearance, with their white walls and red roofs, of cleanliness and health—an appearance which is upheld by the tasteful interior furnishing and decoration in the farmhouse. All farmhouses are supplied with electricity and water. The compact buildings on the small farm provide room for 5–10 milking cows, 10–20 pigs, 2–4 horses, 2 or 3 calves and numerous poultry, but because of shortage of concentrated foods, the accommodation for pigs and poultry is not now fully utilized.

The materials used in buildings are of a substantial nature, since the cattle remain indoors for seven months of the year, and the pigs are never put out at all. Adequate ventilation and warmth are regarded as being most important. The walls and floor are insulated with either clinker and stones, or large slabs of aerated concrete, and baffled ventilators and double windows are commonly used.

It may be of interest to describe the organization of one particular farm which I visited, but I should point out that this is probably one of the more efficient and should not be regarded as typical of its class. This holding of 15 acres is situated in North Zealand. The farmer and his wife did all the work themselves, and had begun farming under the State Land Settlement Scheme.

The farm was divided into seven strips, each of approximately the same size, and with no fence or hedge separating them. The following seven-year rotation was practised, each strip being under a different crop : grass and clover (first and second years)—oats—potatoes—wheat—fodder-beet—barley. The rootbreaks might also include a little clover or other leguminous plants, swedes or beetroot. A high standard of crop husbandry was maintained with adequate cultivation, fertilizer, and weed eradication treatments. The average yields, in cwt. per acre, were said to be : wheat and oats 20–24, barley 22–26, potatoes 136, fodder-beet 384. Grass is not altogether suited to the Danish climate, and the dry spring and early summer usually result in hay yields of only 15 cwt. per acre.

The five Red Danish cows kept were tethered on the temporary grass during the five summer months, together with two horses and a six-months-old bull calf intended for sale to a local artificial insemination centre. Milk records showed that the herd averaged 800 gallons at 4.5 per cent butter fat, and the farmer showed me, with obvious pride, one heifer in its first lactation which had just taken a first prize at a local agricultural show. Many smallholders find that milk recording is too expensive to practise, and, while 51 per cent of the cow population is controlled by 1,785 milk recording societies, most of these animals belong to the larger farmers. All the cows on this holding, like 50 per cent of the Danish cow population, were artificially inseminated and a constructive breeding policy had been adopted.

Eight Danish Landrace pigs, seven of which were baconers and the eighth the foundation sow, were housed indoors, and numerous Light Sussex hens, which averaged 200 eggs per year, lived in a permanent hut with a wired run attached.

The farmer was conversant with the nutritional requirements of all his stock, and could discuss with confidence the protein and carbohydrate needs and supplies. Great reliance was placed on the beet tops which he ensiled in a sunken, pre-fabricated silo ; AIV-acid was used only where grasses or clovers were also ensiled. The temporary grass was grazed as late as possible in the autumn in order to utilize to the full all available protein.

The standard of mechanization was low, but a self-binder, single-furrow plough, drill, mower, and a set of harrows had made the farmer fairly independent of his neighbours. Milking was done by hand, and the milk cooled by suspension in a tank of cold water.

In a house surrounded by a well-kept kitchen garden and a small orchard, the farmer and his wife were normally able to live in comfort and security, but this entailed their working an average of 10 hours per day in the winter, and more in the summer. Nevertheless they assured me that the resultant freedom and independence provided adequate compensation.

There appear to be one or two points in such a farming system worthy of consideration. Socially it has obvious benefits. It maintains a considerable population in security and contentment, and the educational standards are high. The advisability, if not the necessity, of cooperation is evident everywhere. The credit facilities have already been mentioned, and I was told that if any criticism must be made of them it is that it is too easy for farmers to obtain large loans.

Economically, however, one wonders if, on the holdings under 75 acres, the productivity obtained per worker is great enough to enable an average of 10 men to be carried per 100 acres. The disadvantages of such a high proportion of labour are obvious, and, in view of the very rapid advance in production methods in Britain and North America due to the increased adoption of efficient and labour-saving machines, it will be interesting to observe whether, in the future, Denmark will be able to compete so successfully in the world's agricultural market. If, however, a social revolution in Denmark saw the establishment of large estates using modern machinery and the need of, say, only 2 men per 100 acres, she would then be faced with a large-scale transfer of workers from the country to the towns, and, while at present many light industries could absorb more labour, there might in time be a serious problem of unemployment.

Large Farms Approximately 40 per cent of the total agricultural area is enclosed by farms of over 100 acres. The economic advantages of a large farming unit over a small one are well known, and, since they may be applied in Denmark as well as in Britain, I was not surprised to find greater specialization and more elaborate machinery on the larger farms. At the same time, a system of mixed husbandry was still practised since, in view of the country's restricted imports, self-sufficiency is of major importance. By using more up-to-date implements, the average number of labourers per 100 acres has been reduced to 4, while the intensity of production has been maintained. The nature of the labour has also changed and only 20 per cent of those employed on such farms are members of the farmer's family. Eighty-five per cent of these hired labourers (representing 36 per cent of the total agricultural population) are composed of young unmarried men and women, who receive food and lodging on the farm.

Again, it may be of interest to describe the organization of a particular large farm, but the warning that this is definitely of a more progressive nature than most and cannot be regarded as typical, must be repeated.

This holding, situated in Zealand, was of 450 acres, and mainly concerned with milk production. The farmer and his wife displayed many of the same characteristics as did their smaller neighbours, but, since their working

day was considerably shorter and their profits larger, they lived more luxuriously. The buildings were large, modern, and conveniently situated in the form of a square, of which the house occupied one side.

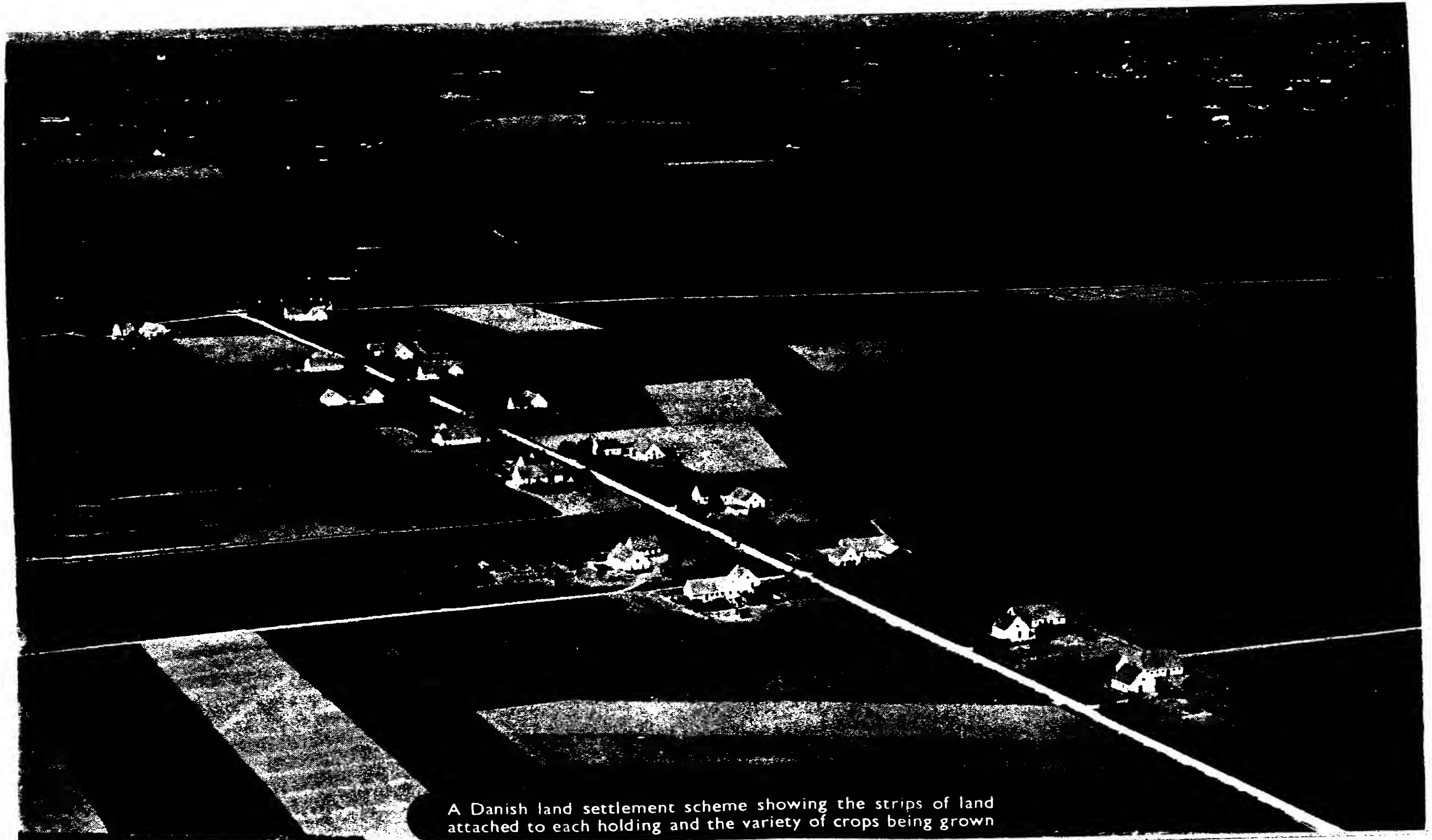
One-third of the farm was in grass, of which two-thirds were in a two-year ley and the remainder down for seven years. Half of the land was in corn, and the remainder roots—mostly fodder-beet. During the recent war, when no imported concentrates were forthcoming, the farmer was obliged to put at least 10 per cent of the total area in mustard or linseed and 40 per cent in corn. Many farmers still grow fair amounts of mustard or linseed ; they send it to a local factory, where the oil is extracted, and they buy the residue as concentrates for their cattle. Since the quantity and quality of his concentrates depend upon that of his own crops, the farmer is careful to maintain as high a standard as possible. Roots are acknowledged to be a very expensive crop, but they produce twice as many crop units* per acre as do grain and grass crops, although at the same time it must be realized that a larger number of crop units per working hour are produced by grain than by root crops. The yields of these crops were comparable with those of the smaller holdings.

One benefit which the occupation of their country did bring to the farmers was the drainage of their fields. Every effort was made to keep as large a male population as possible in heavy work, thus preventing the transportation of workers to industrial Germany. The State therefore undertook to pay farmers the cost of land drainage above the 1939 figure. In this way an army of men was profitably employed for three years, and a very large acreage was tile drained.

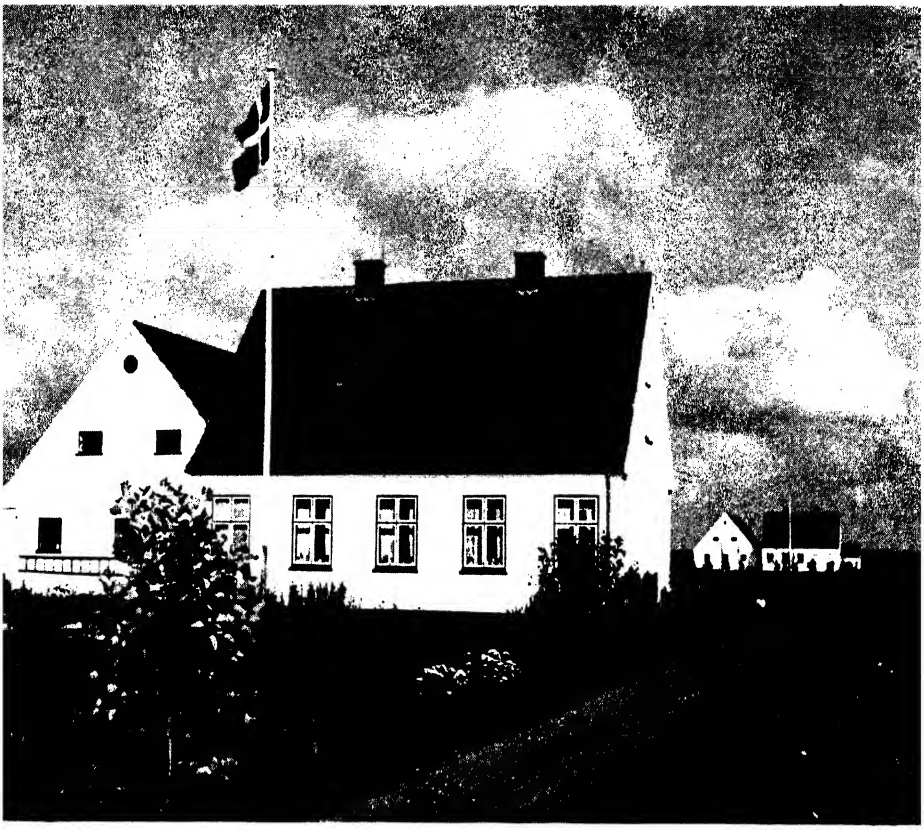
Seventy-five milk cows, of the Red Danish breed, with ninety followers, were kept on the 450-acre farm in Zealand. The cows, with their large, uniform udders and docile, healthy appearance, were an impressive sight. This attested herd, which suffered no abortion and gave no clinical symptoms of streptococcal infection, produced milk for the children's grade. There are three grades of milk, depending on its ultimate use—butter and cheese, liquid milk, and children's milk. The following are the summer prices paid to the farmer per gallon, respectively : 1s. 2d., 1s. 4d. and 2s. These prices have only slight seasonal variations, the lowest of any grade being 1s. 2d., and the normal range for children's milk being 1s. 6d. to 2s. 2d. The herd average of 1,280 gallons per lactation, with a 4.3 per cent butter fat, compared favourably with the country's average of 660 gallons with 3.5 per cent butter fat, and was produced by machine milking three times a day. The milking technique was that of first wiping the udder with a warm cloth, applying the teat-cups for four minutes and then stripping by hand. All these cows were artificially inseminated, and at the end of their profitable milking life were sold, without fattening, for beef. The average life-span for all cows in Denmark is seven years, but on this particular farm it was slightly higher. Calves were removed from their dams soon after birth (heifers immediately, and bulls after one week), and all were subsequently housed in individual pens in which careful precautions against cold and draughts were taken. The floors were raised above the ground, and, together with the walls, were adequately insulated. Baffled sanitary-bend ventilators were featured.

Five sunken silos of beet tops and grass or clover contributed to winter feeding. In addition, on the lighter land fodder potatoes were grown to

* A crop unit is the fodder value of 100 kilos of barley, and the other crops are converted into crop units at a rate fixed by feeding experiments. One crop unit is equal to 100 kilos barley = 120 kilos oats = 110 kilos dry matter of fodder-beet = 100 kilos dry matter of sugar beet and industrial potatoes = 250 kilos lucerne hay = 250 kilos clover-grass hay = 500 kilos straw.



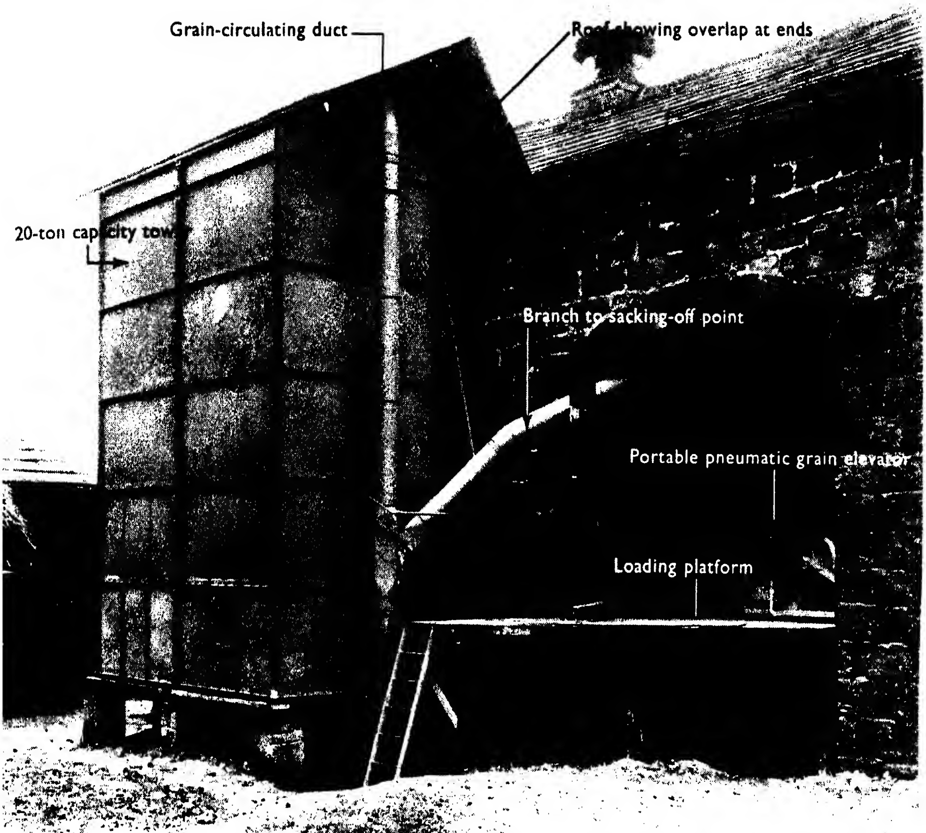
A Danish land settlement scheme showing the strips of land attached to each holding and the variety of crops being grown



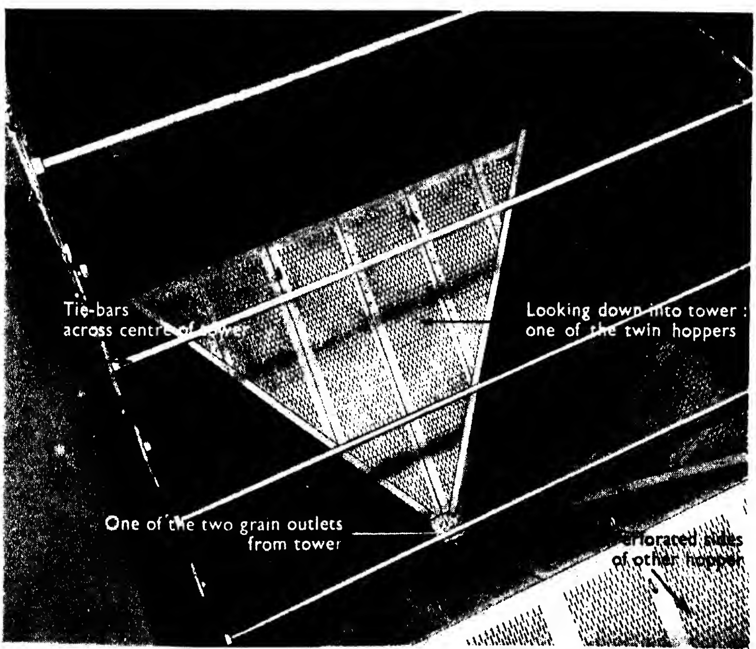
A Danish smallholder's house surrounded by garden and small orchard, with the farm buildings at the back.

Photos: *Danish Agricultural Council Press Bure*

A farmhouse and buildings, forming a square, on a typical large Danish farm.

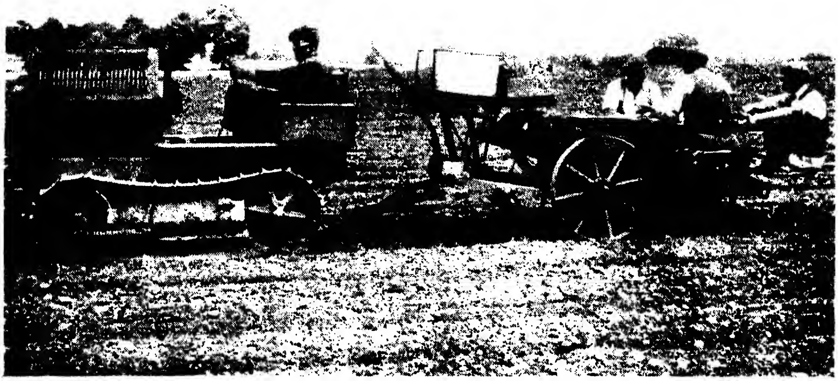


Hoppered self-emptying tower. Note the pneumatic elevator and sacking-off hopper inside the building.

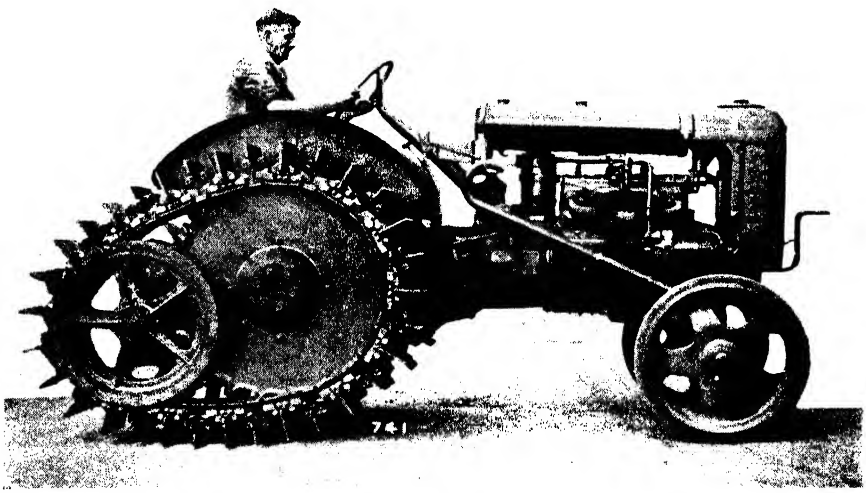


Photos: *Fairmile Engineering Co. Ltd.*

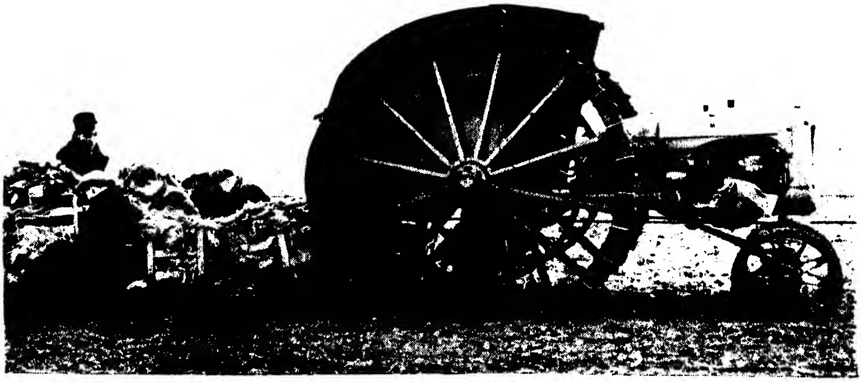
Inverted view of bottom section, showing one of the two perforated hoppers and the cross tie-bars.



An early Robot transplanter, one of the pioneer machines.



Skeleton track, leaving a tilth in its path.



Skeleton wheel and additional reduction gear used for close planting.

provide feed for the pigs. These were boiled at the local cooperative dairy and then ensiled.

Twenty Danish Landrace bacon pigs were housed in a typical Danish piggery, and were to be slaughtered at 6½ months old, at a body weight of about 200 lb.

Bearing in mind that this farm is one of the most progressive in the country, it is surprising that such modern equipment as milking parlours, auto-recording milking machines, combine corn harvesters, modern root harvesters and planters, grass drying plants, etc. were looked upon as a dream that might be realized only in the distant future. There was only one tractor on this farm. It would appear that Denmark, with all her traditional agricultural progressiveness, has yet to realize the great extent to which mechanical devices can be applied to the production of milk and other livestock products. But even so, when she does, it may be that she will not be able to import them in any appreciable numbers.

Fur Farms During the occupation, when the number and variety of available consumer goods were severely restricted and personal incomes had increased, a flourishing fur trade developed on the home market. Besides suitable economic conditions, large quantities of fish, always available in the Danish islands, together with slaughterhouse residues, provided an excellent source of inexpensive food for fur animals. Only a small area was needed for the cages, and labour costs were low.

However, since the occupation, conditions have changed. Money is less plentiful and the quantity of goods on the home market has increased. There is no ready export market for furs, and the quality of furs from other countries is said, in fact, to be better than those of Danish origin. Threats of disease have also occurred, and distemper is becoming a serious menace. Thus a decrease in the present population of 24,000 silver foxes, 103,000 minks and 33,000 beavers, is prophesied, although this branch of Danish agriculture is always likely to flourish to a limited extent.

SOILLESS CULTURE

Readers interested in the development of soilless culture as a scientific branch of horticulture will be interested to learn of the formation of the *Soilless Culture Society* (Hon. Sec., C. Ticquet, 20, Dark Lane, Hollywood, nr. Birmingham). Membership, including subscription to the Society's quarterly journal, is one guinea a year.

STORAGE DRYING OF GRAIN

R. A. Vinter

Yeadon, Leeds

THE use of forced air for the ventilation and drying of grain is, to my way of thinking, the nearest approach to natural drying. Grain dried in this way is not subjected to excessive heat; a temperature rise of about 14°F. above that of the ingoing air is sufficient.

For over three years we have been experimenting with this kind of grain drier and our opinion is that we now have the answer regarding the storage and treatment of combine-harvested grain. We have, in our plant, successfully dealt with wheat, barley and oats having an initial moisture content of upwards of 25 per cent, particularly during the snows of the 1946–47 season, when we dried barley for the Ministry of Food. A test of S.147 oats after five days (drying to 14 per cent moisture) showed 98 per cent germination.

So confident are we of the efficacy of this system, which we prefer to call "storage drying," that we can now fill our towers, start up the blowing fan, apply the heat, and, except for an occasional visit to make sure that the fan is still running and the heating arrangement is in order, forget it for four or five days.

To be able to dismiss the drying problem from one's mind for a few days is a great boon during the harvest period, particularly to us in the West Riding of Yorkshire, where last season we had to snatch the grain from the elements at every favourable opportunity. We made as many as ten attempts over as many days to cut about 16 acres of barley; sacks of corn from the combine were getting soaked as they lay on the ground waiting to be picked up, but it held no terrors for us. As the grain was delivered by the trucks, so it was transferred to the towers and drying proceeded. We often wondered if we could deal with and satisfactorily dry corn under such conditions, and we now know it to be a practical proposition requiring, moreover, no special attention other than a thorough mixing, which is easily achieved with hoppered self-emptying towers.

Hoppered Towers Originally we had flat-bottomed towers with an outlet at the side, near the base, but this involved a considerable amount of hand work inside the towers when emptying. We then decided that if the towers were hoppered, all hand work would be eliminated. This hoppering also allowed us to introduce forced air with a blowing fan, and our hoppers were, therefore, made of sheet steel perforated to allow air to pass through the grain, but with the perforations small enough to prevent small grain from falling through.

The illustration on p. iii of the art inset gives a good impression of what the towers are like. They are built in panel sections of 6 feet × 3 feet, and the bottom tier contains twin hoppers, the space between the hoppers and the outside panels being the chamber into which the air is forced to find its way through the perforations in the hopper and upwards through the grain. To start with we lagged the outside of the towers with asbestos but subsequently found this to be unnecessary.

The towers, each of which holds 100 quarters, can be erected in any corner, and can be easily dismantled and re-erected to suit subsequent re-planning.

A lean-to roof is all that is required, provided an ample overhang is allowed; in fact, the open ends have a decided advantage, in that they allow the moisture-laden air which comes off the grain to escape more readily and not condense on the roof.

The latest tower has a bottom section of expanded metal, covered with asbestos. This, of course, was the correct thing to do because the bottom

chamber has no corn in it, and it is essential that there should be as little loss of heat as possible.

In the next storey the panels are of aluminium. The cost of aluminium sheeting is only slightly higher than that of steel, and its use is, therefore, quite economical.

The next floor above is sheet steel (second-hand) and the top floor, beaver-board. The latter is very expensive and indeed does not appear to be very satisfactory. It seems that future towers will have to be built with aluminium sheets.

For filling the towers we use a portable pneumatic grain elevator, which can be seen inside the building near the loading platform.

Four to Five Days' Drying As soon as the hoppered part of the tower is full, the blowing fan is switched on and the air stream heated by a set of electric heaters placed at the air inlet of the fan. This application of heat has the effect of raising the ingoing air temperature by approximately 12° to 15°F., so drying or removing some of the moisture from the grain. Although we have kept careful records—almost daily—of the drying process and consequent loss of moisture, we find that from a practical point of view it is not really necessary; a check of the moisture content of the grain after about four days is all that is required.

From this it will be gathered that it is not essential to have a man on the site at all times, but after a short period (say, four days) it may be found advisable to turn or circulate the grain. This can easily be done by opening the shutters at the bottom of each hopper and transferring the grain from the bottom of the towers back to the top through the vertical pipe seen in the illustration.

Emptying is carried out in a similar manner, except that in this case the grain is carried through horizontal pipes underneath the towers and thence to a sacking-off hopper, or to other towers situated inside the building; the fan providing the air for ventilation is used also for moving the grain, so doing both operations at once.

The hoppered towers cost about £2 per quarter of storage capacity. The ventilating unit, consisting of blowing fan, heaters, and the necessary ducts, costs approximately £220. The ventilating unit will deal with 250 quarters at one time. Erection and foundation work can be carried out by ordinary farm labour.

The average cost of drying, including the use of the portable unit for filling the towers, works out at 18s. to 20s. per ton of grain dried.

It is perhaps best to have a number of towers, the total capacity of which must be decided according to the average anticipated yield from all fields, for obviously it is not always advisable or desirable to mix the corn. Storage and drying are no longer problems with us: the towers are waterproof, weatherproof and verminproof, and the whole installation is so simple that a working knowledge can quickly be acquired by any farm worker.

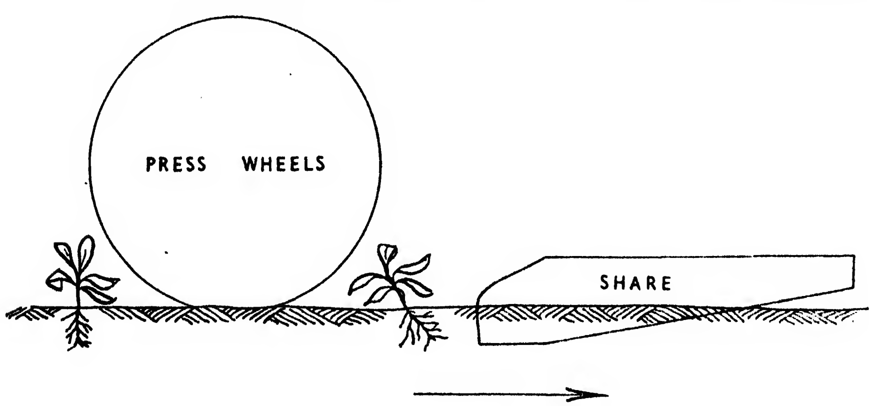
MECHANIZED TRANSPLANTING

DOUGLAS R. BOMFORD
Pitchill, Evesham, Worcs

MECHANICAL aids to the transplanting of horticultural crops have gradually become more general since the development of the first transplanting machines about eighteen years ago. All transplanting machines have certain structural features in common. A framework carries a long share, shaped to cut the ground with a slicing action and leave behind it a deep, narrow channel into which the roots of the plants are placed. Behind the share is a pair of press wheels running on either side of the channel. These close the channel and consolidate the soil around the roots of the plants. The principle is illustrated below.

Speed of Planting Planting is not fully mechanized, and on the frames of all machines now in use seats are provided for the operators (sometimes called "plant droppers"), who take the plants in bunches and feed them singly into the plant-carrying mechanism of the machine or directly into the channel opened up by the machine. This limits the speed of planting to that at which the plants can be handled—on an average about 45 per minute. One mile an hour is 88 feet per minute, so that for a plant spacing of 1 foot in the row and with only one operator per row, the machine must move at about half a mile an hour. This is a convenient figure to remember. Plant spacing of 2 feet will require a speed of 1 m.p.h., 3 feet 1½ m.p.h., and so on. There are exceptions to this. Picked and trained operators will exceed the speed of 45 plants a minute, particularly when working with small plants or plants like leeks or onions which have a compact leaf shape.

Obviously very large plants will reduce the handling speed. A large proportion of transplanting machines are used to plant spring cabbage in September, and most growers like spring cabbage to be big at the time of transplanting. This is one of the more difficult crops to plant successfully with a machine because the large leafy plants lower the speed of handling, and their bulk and weight make it difficult to carry enough plants to avoid frequent stops for re-loading. These plants are often placed 1 foot apart in rows 18 inches apart, which means about 29,000 plants per acre. This makes hand planting an expensive operation, and machine planting of spring cabbage is consequently becoming increasingly popular in spite of the difficulty of carrying and handling the plants. The slow speed of handling



these plants may reduce the travelling speed of the transplanter to five or six hundred yards an hour where only one operator per row is available.

With the Robot transplanter it is possible for operators to handle plants of normal size at speeds greater than the normal, because the single plants need not be released from the hand at a constant speed. When working this transplanter the operators have running crossways in front of them a conveyor on which upwardly projecting pegs are arranged in pairs. The operator places the leaf end of each plant between a pair of pegs, thus enabling him to use his hands in a different way. Instead of holding a bunch of plants in one hand and drawing from it single plants for planting with the other, he can take four or five plants at a time from the bunch and " thumb " them down between the pegs. On this machine the placings of four operators are conveyed into a single row so that much greater travelling speeds are possible. The single row may be receiving 200 plants per minute, so that at a plant spacing of 1 foot speeds of over 2 m.p.h. are possible.

The Pros. . . In most conditions machine planting provides the following advantages over hand planting with the usual setting pin :

1. The plants are given a better root spread by being set in a trench instead of being confined in the bottom of the conical hole made by a setting pin. This gives them a quicker start, followed by better growth.

2. The consolidation of the soil round the plant roots by the press wheels of the transplanter is more effective than consolidation by a setting pin. It reduces plant mortality, especially when the soil is dry.

3. The working of a transplanter requires less skill than hand planting with a setting pin. Bad work with a setting pin which cannot always readily be detected results in a high rate of plant mortality ; with a transplanter the responsibility rests much more with the machine than with the operator. Any unskilled person who is not clumsy with his fingers can operate a transplanter.

4. The number of plants set per man-hour is appreciably greater. Apart from lowering labour costs, this acceleration enables the grower to make better use of limited periods when soil moisture is right for the job. If a given acreage takes twice as long to plant by hand, the disadvantage of having to stop planting because of drought or excessive wet is accentuated. Timing is all-important : delay may result in plants getting too large in the seedbed or the whole crop may be put out of season—for example, cabbage will not sell when fresh green peas are plentiful.

5. On some machines a water injector can be fitted to make planting possible in dry conditions.

6. On some machines it is possible to fit a fertilizer injector which applies a small quantity of nitrate round each plant in the trench.

7. On some machines a scraper is fitted in front of the share so as to grade away a strip of dry top soil and prevent any of it from falling into the trench with the plant roots. This reduces the plant mortality rate.

8. From the operator's point of view, work on a transplanter is less tiring than hand setting.

9. The marked simplicity of many of the machines. Some of these have no moving parts other than the press wheels, which serve the double purpose of carrying the back end of the transplanter and of consolidating the soil round the plant roots.

. . . and Cons Against the transplanting machine must be recorded :

1. In wet conditions it may be possible to plant by hand when machine work is impossible.

2. It is difficult to space the rows evenly with machines which plant only one row at a time. This usually makes close and accurate machine-hoeing impossible and tends seriously to increase the cost of subsequent cultivations.

3. The capital cost of the equipment.

4. The low speed requirement. It is doubtful whether any tractor now in production can move slowly enough to enable a single operator feeding a row to plant large, leafy cabbages at a spacing in the row of 12 inches, or leeks at 6 inches.

5. The inability of machines to plant on the square with sufficient accuracy to enable the crop to be cross-cultivated.

Machine transplanting has reached a stage at which it is sound practice for almost any large-scale vegetable production unit to adopt it, but with most crops there are irksome limitations which urgently require more development work. These arise from the difficulty of using a transplanter in a way that will avoid trouble in the subsequent working of the crop.

Widely Spaced Crops Where crops such as brussels sprouts and cauliflower require to be widely spaced, it may be argued that with only about 5,000 plants per acre hand planting is inexpensive and makes accurate "squaring" possible. The advantage of cross-cultivating in plants on the square is undeniable. Nevertheless some of the largest and most progressive growers are planting sprouts with six machines "ganged" together in a row behind a single tractor. Only one plant dropper per row is carried, but for every two men dropping plants one man is carried to hand them bunches. This makes a total gang of ten, including the tractor driver. The total wage per hour is in the neighbourhood of 20s. and, as the area planted per hour in reasonable conditions is about 1½ acres, the labour cost is about 13s. 4d. per acre. As many as 15 acres can be planted in a day if a little overtime is worked. Admittedly this crop can be cultivated only in one direction, but one-direction cultivation can be accurate for three rows at a time, leaving only a narrow strip for hoeing by other means. The important factor in favour of planting in this way is the capacity to plant large acreages when the moisture content of the ground is right, thus reducing plant mortality to a minimum and ensuring a quick "getaway" for the plants.

Square planting with machines where the operators place the plants directly into the channel in the soil should not be difficult if the ground could previously be marked in parallel lines running across the direction of planting. It would then only be necessary for each operator to drop his plant on the cross mark. It has been found that the ordinary marker which only scratches a line in the soil is not good enough for this purpose. It is easy for an operator to place his plant accurately on a cross mark if the mark is clear, but there is not time to look around for it. A marker which leaves a narrow, clearly marked line of a colour different from that of the soil is needed, and development work in this direction should yield satisfactory results.

Closely Spaced Crops The same problem of accurate after-cultivations arises with closely spaced crops such as spring cabbage or leeks. Here the rows are about 18 inches apart, with the plants from 6 to 12 inches apart in the rows, which rules out any possibility of cross-cultivation. But it is important that these rows should be so accurately spaced that up to six of them can be side-hoed simultaneously by a hoe taking the width of the six rows.

Growers who use motor toolbars capable of cutting weeds within an inch of the plant stems will acquire a very high standard of accuracy if the toolbar

is to be used to its full advantage. This can be achieved only by " ganging " six transplanters together as with the planting of brussels sprouts. But the " ganging " of six transplanters for cabbage planting is not so easy as for sprout planting. Allowing for only one dropper per row, he will have to sit and work in a space only 18 inches wide unless the planting machines in the " gang " are staggered into two rows. Both methods have been used. With the six transplanting machines " ganged " in a single row, the movements of the droppers are cramped. With the machines " ganged " in two rows, too much time and space is lost in turning on the headlands. Here again, development work is needed. The plant droppers might have more elbow- and knee-room if their machines were partially staggered.

For these closely spaced crops, speeds down to 400–500 yards per hour are needed, while the tractive effort required is sometimes as much as 500 lb. per row. This means that the tractor drawing six " ganged " transplanters must be capable of a consistent pull of 3,000 lb. on soft, deeply cultivated ground, and that it must exert this pull at the required minimum speeds. An added requirement is that the tractor shall be as light as possible to avoid ground consolidation and that the design of tracks or wheels shall be such as to leave a tilth in their path. No tractor in normal production fulfils these requirements, but some have been suitably adapted.

Very large diameter skeleton wheels or skeleton tracks have been used in combination with an additional reduction gear in the transmission and have given satisfaction, but growers have had to make their own arrangements for the construction of the additional parts.

Unfortunately little or nothing has been done to fulfil the transplanting requirements of the small-scale horticulturist. The need here is to provide a machine that will not overtax his capital resources. He will not be able to buy many machines, and the machine offered to him must, therefore, perform as many operations as possible. If it is a self-propelled transplanter, it should also be capable of inter-row cultivation, inter-plant cultivation and, if possible, of reasonably deep primary cultivation before planting.

THE POTATO ROOT EELWORM PROBLEM

B. G. PETERS, M.Sc., Ph.D.
Rothamsted Experimental Station, Harpenden, Herts

THE potato root eelworm (*Heterodera rostochiensis* Wollenweber, 1923) has been known since 1881, when it was found in Germany by Kühn. It was first found in Great Britain by Massee in Scotland in 1913 and by Taylor in Yorkshire in 1917. Crop failures in Lincolnshire occurred soon after this, and by 1924 the eelworm was recognized as the probable cause. It has long been a pest in Sweden, and since the war ended it has been reported from several other European countries ; on the American continent it appears to be confined to Long Island. During and since the war the increased need for potatoes has resulted in (a) a wide extension of land under the crop, leading to a further spread of the parasite, and (b) a too frequent recurrence of potatoes in the rotation, leading to an increasing intensity of infestation—sometimes to such dangerous levels that the crop weighs no more than the seed planted.

For many years this eelworm was called *Heterodera schachtii*, along with the other cyst-forming species attacking sugar beet, brassicas, peas, cereals, hops, and other hosts. The species *H. schachtii* was thought to contain a number of biological strains each specializing in a different group of host

plants but possibly capable of transferring to others. Largely as a result of the careful anatomical studies of Franklin, it is now recognized that these "strains" are, in fact, separate species, with minute but constant points of difference in their structure. The name *H. schachtii* is retained for the sugar-beet eelworm, but other names are now used for the other forms. *H. rostochiensis*, named after the German town of Rostock, apparently confines its attacks to species of the natural order *Solanaceae*. Apart from the potato, the only important host is the tomato, much damage being done to tomatoes under glass when grown in infested soil. In addition, a few solanaceous weeds are known to be attacked, including bittersweet (*Solanum dulcamara*) and deadly nightshade (*Atropa belladonna*), but no heavy infestations have been found on these weeds, and they are probably not important in the ecology of the parasite.

The Parasite *Heterodera rostochiensis* is an eelworm or nematode. The larvae are transparent, slender, worm-like creatures about one-fiftieth of an inch long and invisible to the naked eye. From the soil they penetrate into the outer layer of potato rootlets, where they wander, feeding on the cells in their path. The adult males, which are also transparent and worm-like, leave the roots after fertilizing the females. These adult females swell up and become a creamy white in colour, the body later bursting through the skin of the root but remaining attached by the head. Finally, they become almost spherical in shape and, during the autumn, their colour gradually changes through golden yellow to brown. At this stage the female can no longer be regarded as a living worm : it has become little more than a tough brown sphere full of eggs and is known as a cyst. This, the resistant stage, falls off the roots into the soil, where it can remain for many years with living eggs inside it. These eelworm cysts measure about one-fiftieth of an inch in diameter and are just visible to the naked eye. Each may contain up to 600 eggs. In subsequent years some of the larvae hatch from their eggs and escape from the cyst into the soil, stimulated by a substance diffusing through the roots of growing potatoes. So the cycle continues.

Present Distribution The reports of the Ministry's Advisory Entomologists show that, where potatoes are grown on a field scale, there are four major areas of eelworm damage : (a) in parts of Lincolnshire and Norfolk around the Wash and in adjacent areas of Cambridge, Huntingdon, and the Isle of Ely, (b) in the lower valleys of the Yorkshire Ouse and the Trent, (c) in the coastal plain of Lancashire, and (d) in the Greensand area of Bedfordshire. In addition there are bad patches in the counties of Durham, Nottingham, Stafford, Worcester, Cornwall, Devon, Dorset, Isle of Wight, and Surrey. In fact, these bad eelworm areas correlate with the chief potato areas. Apart from field cultivation, the parasite is now common and widespread on allotments in most parts of the country.

How the Cysts are Spread A fairly heavily infested field has at least 500 eelworm cysts in each pound of soil and, within a farm, the cysts are readily carried from field to field on tractors, implements, and boots. Over longer distances cysts are spread not only by the obvious vehicle of soil-dust on seed potatoes, but also when brassicas and other seedlings are transplanted from infested into clean soil. Brassicas are not attacked by this species, but the soil clinging to their roots may contain cysts.

In a country where eelworm has just been introduced, chemical or other treatment of seed potatoes to kill the eelworms would merit careful attention.

Here, where the pest is already so widespread, such measures are less valuable except where clean land is being brought under potatoes for the first time. Triffitt and Hurst[1] found that temperatures around 120°F. were necessary in hot water treatment. Franklin [2,3] has shown that 5 per cent formalin can be used on a laboratory scale with little harm to most potato varieties, and Fenwick[4] has had even better results with the use of sulphur dioxide on unchitted seed. The transplant situation can readily be controlled by growing seedlings only in clean soil or by ensuring that transplants from infested soil are planted only in fields already infested.

Degree of Infestation In land regularly under potatoes, a recently introduced infestation will tend to be built up by "compound interest," the population being multiplied by a certain factor each year. Thus, if this factor were as high as 10, the population in successive years would be in proportion to 1, 10, 100, 1,000, etc. Little is yet known about the magnitude of this factor, except that it certainly varies considerably according to soil type : the eelworm tends to prefer light, well-aerated soil. At some population level, again varying with soil and other local conditions, disease symptoms appear. Plants are stunted and have smaller root-systems capable of carrying fewer cysts. At this stage the multiplying factor rapidly declines to unity.

If potatoes are withheld for a number of years the population falls a certain percentage each year. The rate of fall is not known with any accuracy, but it is a matter of common experience that when potatoes are grown after a rotation of non-susceptible crops, a population can recover to something like its original level in a single year. The rate of decrease is, therefore, considerably lower than the rate of increase.

Control by Rotation It is possible to exterminate this eelworm in experimental pots of soil, and even perhaps in glass-houses if very great care is taken. Once, however, the pest has become widespread over a whole country, as in Great Britain, extermination is quite out of the question, and the problem is how to keep the population below the level at which serious loss of yield occurs.

The most obvious means of control is rotation with non-susceptible crops, i.e., with any crops other than potatoes and tomatoes. Rotations of four or more years have been recommended, but it is not possible to recommend any length which would be applicable generally. If, for given local conditions, the annual rate of increase in the presence of potatoes were known, and also the annual rate of decrease in their absence, the desirable length of rotation could probably be forecast with reasonable accuracy.

It is one thing to plant a non-susceptible crop after potatoes, and another to ensure that potatoes are in fact absent ; the eelworm's rate of increase on potatoes is so much greater than its rate of decrease in their absence that the growth of only a few groundkeepers may largely spoil the good effects of rotation.

Chemical Control In the laboratory it is simple to kill eelworm eggs within their cysts, using any one of a hundred chemical agents. In the field it is extremely difficult : either the agent is not sufficiently effective, or its use is economically impracticable. The search for an efficient and cheap agent has been going on in Germany for some sixty years, and in Britain since 1925 at least, and it still goes on. It is not possible in this short article to recount the history of the earlier experiments in chemical control ; it may be valuable, however, to mention some of the difficulties encountered.

First in importance is the difficulty of bringing the chemical agent into intimate contact with the cysts, which, although commonest in the upper 10 inches of soil, may be found in small numbers as deep as 24 inches or more. On an acre of soil the top 8 inches involves over 1,000 cubic yards, and every extra inch in depth means a further 134 cubic yards; the volume of soil to be dealt with is enormous. If the agent is a solid, it needs to be applied in a state of fairly fine subdivision and then thoroughly mixed. If it is a vaporizing liquid, injected at points or in strips, a new set of problems arises; the need now is to secure a sufficient concentration of vapour, for a sufficient length of time, in all parts of (say) the top 10 inches of soil. The vapour may diffuse too rapidly for the concentration to be reached, or too slowly to affect the soil midway between points or strips. Temperature and soil moisture are of critical importance here. Experience shows that the top inch or two of soil is especially difficult to treat unless the surface can be sealed in some way. Moreover, any agent which is poisonous to eelworms may well be poisonous to plants also, and ample time must therefore be left between injection and planting for the agent to disperse.

From the first, difficulties of interpretation have arisen owing to the fact that many chemical agents stimulate plants to make better growth, by acting either as an artificial fertilizer or as a soil sterilizer. When eelworm "disease" occurs on hungry land, a chemical agent may lead to startling improvements in appearance and yield without killing eelworms at all. Indeed, since a better plant can support more eelworm cysts, such an agent may greatly increase the eelworm population. The agent may both kill eelworms and stimulate plants, in which case the end result depends on the relative powers of these two effects. In recent trials with the soil fumigant known as D-D mixture there was evidence that rather more than 40 per cent of the eelworm population was killed; but potatoes planted on the treated plots made better growth, the surviving 60 per cent of eelworms multiplied greatly on their roots and, at the end of the growing season, the eelworm population was slightly higher on the treated plots than on the (untreated) controls.

A fundamental difficulty in the chemical control of eelworm is the resistant nature of the cyst wall and the egg shell. Chemically, these two tissues are related but not the same; like the cuticle of all nematodes, they are also related to the chitin of insects. Similar difficulties have beset the attempts to kill nematodes parasitic in animals. In this field some of the most effective agents have been simple, halogenated hydrocarbons (carbon tetrachloride, tetrachlorethylene, hexachlorethane), and it is significant that the more promising modern eelworm fumigants are also halogenated hydrocarbons (methyl bromide, ethylene dibromide, D-D mixture).

Recent Trials During the war eelworm control became a matter of high priority in many countries. In the Hawaiian pineapple plantations Carter[8] found that a waste product called D-D mixture not only acted as a valuable partial sterilizing agent ("soil amendment") but also killed the root knot eelworm. At St. Albans it was tested against potato root eelworm and gave very promising results which, in the opinion of the Agricultural Research Council, justified more stringent tests on a field scale. In 1946-47, Agricultural Research Council trials were carried out on seven 2-acre sites in the principal potato areas, by the Institute of Agricultural Parasitology (now the Nematology Department of Rothamsted Experimental Station), with the cooperation of the Advisory Entomologists at Cambridge, Loughborough, Leeds and Manchester, the Shell Refining and Marketing Co., the Statistical Department and the Soil Survey of England and Wales at Rothamsted, chemists of the Imperial College of Science and Technology,

the Northern Ireland Ministry of Agriculture, and the County A.E.C. officers at Bedford, Lincoln, March, Snaith and Wigan. D-D, a black vaporizing liquid composed of dichloropropylene, dichloropropane and various impurities, was used at 200, 400, and 800 lb. per acre, at 4 inches and 8 inches deep, with and without subsequent rolling to form a seal. Injection of the soil was carried out in October and potatoes were grown the following year.

The results have been considered by the Agricultural Research Council and will be published in detail elsewhere, but it may be stated that they fell far below earlier promise, and far below those reported from Long Island. Their discrepancy from the latter may be due to the higher soil temperatures in Long Island; their discrepancy from the earlier St. Albans trials is difficult to explain, unless batches of D-D vary in their effectiveness (as a mixed waste product, it is very difficult to standardize). It was in these trials that after growing a crop the eelworm population was slightly higher on the treated plots than on the controls; the increase in yield of approximately 50 per cent was dearly bought, for by the end of the experiment the eelworm population had, on the average, doubled itself. In practice, of course, it would be unwise to plant potatoes immediately after an injection; if a non-susceptible crop reaped the benefit of the soil amendment effect, no abnormal increase in the rate of eelworm multiplication need follow.

Biological Control Biological control is here taken to mean any method of interfering with the normal biology of the eelworm, short of killing it. Thus in 1925 Morgan(6) accidentally found that potatoes grown with mustard were less heavily infested with cysts. Later confirmed and extended by Triffitt(7,8), this line of research is carried on today mainly by Ellenby(9); mustard oil is used to inhibit the substance exuded by the roots of growing potatoes which stimulates eelworm larvae to hatch.

A quite different effect was given by several grasses which were shown by Triffitt(10,11) and Franklin(12) to stimulate the hatching of potato root eelworm larvae without themselves being attacked. The importance of this lies in the fact that the eelworm is less well able to survive as a free larva than as an unhatched egg within a cyst. Even so, it can so survive for many months. Since the hatched larvae are more vulnerable, an unexplored development would be to follow grass-sowing (as a temporary ley) with injection.

A logical extension of this idea is the trap-crop method, designed by Kühn at the end of the last century for controlling the beet eelworm. An alternative host is sown, becomes infested with eelworm, and is lifted and destroyed before any cysts mature. For the potato root eelworm there is no practical alternative host; Carroll and McMahon(13) discussed its possible use by planting potatoes, lifting and destroying them after a few weeks, and following with a non-susceptible crop. Difficulties beset this method, which is not now used even for beet eelworm, and if it were mishandled it might increase rather than diminish the eelworm population.

Of considerably greater promise is the recent progress in chemically analysing the active principle diffusing from potato roots which stimulates hatching. The chemical constitution of this principle is now under investigation by Professor A. R. Todd and his colleagues at Cambridge, who have given it the name "eclepic acid". The detailed structure of this substance is not yet known, but it has been possible to synthesize certain other compounds such as anhydrotetronic acid which are active, although considerably less so than the natural product. If such a compound could be produced cheaply, it could be used on infested ground in the absence of potatoes to make the larvae hatch. Once hatched, larvae would be far more vulnerable to the effects of fumigation or rotation.

The Outlook It is understood that the work on chemical hatching is to be actively extended, at Cambridge, under Professor Todd's direction. The further examination of D-D and other fumigants is also in hand at Rothamsted and elsewhere. A start is being made in measuring the rates of increase and decrease of eelworm populations in various types of soil and under various conditions. This is not a pedantic but a highly practical question; to revert to the earlier example, if the rate of annual increase were as high as tenfold, and if it were possible to find a fumigant killing 99 per cent of eelworms (this would be a very good fumigant!), the eelworm population would nevertheless be back at its original level after only two successive crops of potatoes.

So far as it is possible to foresee, it seems likely that various methods of control will be combined. When population rates are known, chemically stimulated hatching after a crop of potatoes will be followed by fumigation, and then by a short rotation of non-susceptible crops. In some areas it may be possible to work in a grass crop before fumigation. As long as the decrease in population brought about by all these methods is not less than the increase from a single potato crop, the population can be kept under control.

To the practical man it must sometimes appear that little or nothing is being done about potato root eelworm. This is far from the truth; much time and money are being spent on it. For many technical reasons the eelworm is a difficult animal to work with, and experiments have to be cumbersome and prolonged: for example, in the Agricultural Research Council trials with D-D mixture, nearly 1,500 soil samples had to be taken through complex processes, and over a million cysts, eggs and larvae had to be counted. Even then, the averages which measured the effects of treatment were not so steady as the statisticians would like.

The recent war has greatly intensified the problem, but although the present position is serious the outlook is not hopeless.

References

1. TRIFFITT, M. J. and HURST, R. H. On the Thermal Death-point of *Heterodera schachtii*. *J. Helminth.* (1935) **13**, 219.
2. FRANKLIN, M. T. The Treatment of Seed Potatoes for the Destruction of Adherent *Heterodera schachtii* Cysts. *J. Helminth.* (1939) **17**, 113.
3. FRANKLIN, M. T. The Effect on Seed Potatoes of Formalin Treatment for the Destruction of Adherent Eelworm Cysts. *J. Helminth.* (1940) **18**, 85.
4. FENWICK, D. W. On the Lethal Effect of Sulphur Dioxide on Eelworm Cysts adherent to Seed Potatoes. *J. Helminth.* (1942) **20**, 41.
5. CARTER, W. A Promising New Soil Amendment and Disinfectant. *Science* (1943) **97**, 383.
6. MORGAN, D. O. Investigations on Eelworm in Potatoes in South Lincolnshire. *J. Helminth.* (1925) **3**, 185.
7. TRIFFITT, M. J. Preliminary Researches on Mustard as a Factor inhibiting Cyst-formation in *Heterodera schachtii*. *J. Helminth.* (1929) **7**, 81.
8. TRIFFITT, M. J. On the Bionomics of *Heterodera schachtii* on Potatoes, with Special Reference to the Influence of Mustard on the Escape of the Larvæ from the Cysts. *J. Helminth.* (1930) **8**, 19.
9. ELLENBY, C. The Influence of Crucifers and Mustard Oil on the Emergence of Larvae of the Potato Root Eelworm, *Heterodera rostochiensis* Wollenweber. *Ann. appl. Biol.* (1945) **32**, 67.
10. TRIFFITT, M. J. Preliminary Note on the use of Root Excretions as a Method of Controlling the Nematode *Heterodera schachtii*. *J. Helminth.* (1932) **10**, 181.
11. TRIFFITT, M. J. Experiments with the Root Excretions of Grasses as a Possible Means of eliminating *Heterdocra schachtii* from Infected Soil. *J. Helminth.* (1934) **12**, 1.
12. FRANKLIN, M. T. The Effect on the Cyst Contents of *Heterodera schachtii* of the Cultivation of Maize on Potato Sick Land. *J. Helminth.* (1937) **15**, 61.
13. CARROLL, J. and MCMAHON, E. Potato Eelworm (*Heterodera schachtii*): Further Investigations. *J. Helminth.* (1937) **15**, 21.

Twice Ploughing War-time experience has shown the great importance of good cultivation: the poorer the land, the greater the need for thorough tillage. Autumn crops may be sown on a rough tilth—though some crumb in the seedbed is essential and winter frosts will crumble down the clods. With spring-sown crops, a kindly tilth at sowing time is most important. Farming tradition is that barley needs a well worked seedbed. The explanation often given is that the barley plant has a weak, shallow root system. But even more important is the season. All spring corn should be sown in a kindly tilth, so that it may get away quickly from birds and have a full season's growth. With root crops, the seed is very small and has to be sown very shallow, so aim at absence of clod and plenty of crumb. Even for potatoes, good tilth is important to get satisfactory ridges that will not dry out.

All farmers know the importance of winter ploughing for spring sowing so that the upturned furrows get the benefit of frost. But is one ploughing enough? If the land is in good heart and laid in well set up furrows by Christmas, and if severe weather comes along in January or February to freeze the furrows right through, then one ploughing may well be enough. But you do not always get these conditions, and a second ploughing is then worth considering. Given tractors and a dry spell in February or early March, there is plenty of opportunity. What you gain by cleaning will generally be small, though if the first ploughing was in early autumn, annuals like black grass may have germinated. But you will gain through the furrows having been exposed, and, with luck, frosted top and bottom, so that they will be mellow tilth all through.

In a dry winter a second ploughing is easy; after a wet winter, though more difficult, it is more desirable. Heavy rain often follows severe frost, and the cold weather having crumbled down the winter furrows, the beating rain makes the field wet and sodden and very slow to dry out. You cannot plough while it is still wet, but as soon as fairer weather has dried the top three inches or so, ploughing may well be the quickest way to get it fit for drilling. It lets the air in, and though it may bring up some unkind soil, that will soon dry on the surface and crumble down fairly readily. Winter furrows frosted and then soaked, stay "sad" a long time unless moved. The art of the cultivator is to choose the right moment for ploughing. If too early, the furrow slice will come up glazed and puddled; but if left too late the land may have "set," so that after ploughing it will not crumble until it has dried and then been wetted and dried again.

Dairying in India "In India dairying is essentially a village industry and almost every family keeps one or two milch animals to meet its requirements. For this reason the industry presents many peculiar features, and it is difficult to put it on a factory basis, as has been done in Western countries. The outlook and the scope of the dairy industry are thus in many ways different from those accepted by the Western world. The gross milk production of the country is estimated as 6,129 million gallons. About 90 per cent of the milk produced in rural areas is utilized by the producers for their own use and for preparing milk products, the most important of which is ghee.* The total quantity of milk utilized in urban areas is estimated at nearly 700 million gallons per annum. Only about 6 per cent of the total milk produced in the country is transported from the villages to urban centres for fluid consumption and for manufacturing milk products. Most of the milk consumed in urban centres is produced within the municipal limits.

* Clarified butter, commonly made from buffalo milk.

"Milk is obtained from two main sources, viz., cows and buffaloes. Nearly half of the total milk produced is buffalo's milk, 47 per cent is cow's milk, and the remaining 3 per cent is obtained from goats, sheep, camels, and asses. The present general trend is that buffaloes are gradually replacing cows as milch animals, especially near the urban areas ; for example, during the period 1920-40 the number of buffaloes increased by nearly 15 per cent, whilst the increase in the number of milch cows was only 2 per cent. This trend is largely due to the buffalo giving more milk and milk of higher fat-content than the cow, the buffalo being able as a rule to thrive on coarser feed. Though the total number of milch buffaloes is less than half that of cows, they contribute 50 per cent of the total milk produced The production of cow milk is concentrated in the Punjab (16 per cent of the total), United Provinces (15 per cent), Bengal (14 per cent), Rajputana (12 per cent), and Madras Presidency (10 per cent). Buffalo milk is largely produced in the Punjab (27 per cent), United Provinces (20 per cent), and Madras Presidency (9 per cent). The chief goat-milk producing areas are the Punjab (22 per cent), United Provinces (18 per cent), Rajputana (9 per cent), and Madras Presidency (9 per cent).

"As a rule, the average milk yield per animal is very low and the recorded overall yield per day in the best animals varies from about 12 to 30 lb. The total milk produced by village units is thus very small, thus making collection and disposal on a large scale both difficult and costly "

K C Sen and N N Dastur of the Indian Dairy Research Institute, Bangalore, writing in the October, 1948, issue of *The Empire Journal of Experimental Agriculture.**

East Malling Annual Report, 1947 The East Malling Research Station's Annual Report for its thirty-fifth year† covers nearly 200 pages and is accompanied by an up-to-date account of the development and activities of the Station since its foundation. Its main features are outlined below.

The farm report in Section I surveys the treatment and cropping of all parts of the experimental farm and enables growers to compare their results with those at the Station. The season was favourable and heavy crops were gathered,

In Section II the complete review of all the research in progress, with lists of papers published during the year, shows that all the main problems of fruit growing are being studied and that substantial progress is being made in many directions.

In the research reviews and progress reports on certain subjects contained in Section III, the research worker is writing mainly for fellow scientists, but the language is not highly technical and the progressive fruit grower can derive much valuable information from the twenty-four papers here. Of special interest is the full text of the first Amos Memorial lecture, which was given by Captain R. Wellington on March 11, 1948. This section also includes a report on the year's weather.

Section IV consists of bulletins written specially for fruit growers, whether amateur or commercial. Here in non-technical language are given the practical results that are emerging from the research in progress. The subjects include Intensive Apple and Pear Growing, Winter Injury and Spring Frost Damage, Raspberry Culture in New Zealand and New Varieties, the Official Certification Schemes, the Use of Hormones in Rooting Cuttings,

* Oxford University Press, Amen House, Warwick Square, London, E C 4 9s. : four months' subscription, 27s 6d post free Other articles in this issue include The Problems and Possibilities of Wheat-growing in Australia, Silage-making in the Netherlands, and Silage in Canada.

† Obtainable from the Station, price 10s.

the Control of the Fruit Tree and the Hop Red Spider, and the Propagation of Hops by Layering. Numerous text figures and twenty-seven photographic plates add greatly to the value of these articles.

Research in Agricultural Engineering: Change in Administration After considering recommendations made by the Agricultural Machinery Development Board, it has been decided to make a change in the administration of research in agricultural engineering.

Until 1942, research and development work on agricultural mechanization was entrusted to the University of Oxford. Thereafter the responsibility was transferred to the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland, and the Agricultural Machinery Development Board was established to control the work and to advise on the management of the National Institute of Agricultural Engineering.

The Board is now being replaced by a new and independent Governing Body of the National Institute of Agricultural Engineering, which will receive grants from the two agricultural Departments. The N.I.A.E. was established as the headquarters research station, at first at Askham Bryan, Yorks, and recently transferred to Wrest Park, Silsoe, Beds. This, and the Scottish station at Howden, near Edinburgh, will continue to operate.

On the recommendations of the Agricultural Machinery Development Board, the agricultural Ministers have also appointed an Agricultural Machinery Advisory Committee to advise on the requirements and supply of agricultural machinery. This Committee will be a permanent body consisting of twenty members representing the agricultural and agricultural engineering industries, nominated by organizations within the industries and the interested Government Departments.

The Chairman is Mr. G. S. Dunnett (Deputy Secretary, Ministry of Agriculture), and the Joint Secretaries are Col. C. K. Hamilton (Ministry of Agriculture), Mr. H. J. Lloyd (Agricultural Engineers' Association), and Mr. G. D. Stevenson (N.F.U. for England and Wales) .

Death of Dr. G. Scott Robertson Agriculture has suffered a great loss by the sudden death on December 22 of Dr. G. Scott Robertson, Permanent Secretary of the Ministry of Agriculture, Northern Ireland.

Dr. Robertson graduated at Durham University in 1912 and after various appointments in this country was largely responsible for the creation of the Faculty of Agriculture at Queen's University, Belfast. In 1924, at the age of 31, he became Professor of Agriculture, Dean of the Faculty and Senior Research Officer of the Ministry of Agriculture, Northern Ireland. After being appointed Chief Inspector of the Ministry in 1928 and Assistant Secretary two years later, he became the Permanent Secretary in 1933.

Dr. Robertson's reputation was not confined to Northern Ireland. Apart from the invaluable work he performed in the organization of the agricultural industry of that country, he was a member of the Empire Marketing Board, the Agricultural Research Council, and other bodies. In 1947 he became the first Director of the new Agricultural Production Division of F.A.O., and when he returned to duty in Belfast at the end of the year it was evident that his health had been undermined. At the time of his death he was President of the Agricultural Section of the British Association.

Poultry and Attested Herds : Risk of Tuberculosis Infection Many farmers continue to ask whether poultry may be given free range on farms where an attested or licensed T.T. herd is kept. Avian tuberculosis (the only type of the disease found in

poultry) can be picked up by cattle with their grass or fodder, and may cause them to react to mammalian tuberculin. It is very exceptional, however, for avian infection to cause progressive disease in cattle.

Before the introduction of the comparative tuberculin test, farmers were advised not to let their poultry and cattle run together, but now that both avian and mammalian tuberculins are used, no such restriction is necessary, because it is possible to determine whether reaction is due to bovine tuberculosis or to avian or other non-specific infection.

In certain circumstances, however, there are disadvantages in allowing poultry free range. Many importing countries will not accept animals unless they have passed a tuberculin test with mammalian tuberculin only. As there is a risk that an animal infected with the avian type of tuberculosis may react to the test and be rejected, owners of cattle which may have to pass a test in which mammalian tuberculin only is used would be well advised to keep their cattle and poultry apart.

U.K. Agricultural Advisers in Australia and New Zealand Our agricultural representation overseas has been extended by the appointment of Agricultural Advisers to the United Kingdom High Commissioners in Australia and New Zealand. The representative in Australia will be Mr. C. W. Strutt, B.Sc. (Agric.), and in New Zealand, Mr. D. S. Hendrie, B.Sc. (Agric.), N.D.A., N.D.D.

A similar post has existed in Canada for some time. In the U.S.A., South America and Denmark we have Agricultural Attachés.

Nature Month by Month—February Will "February Fill-dyke" live up to its ancient name this year? Whether it does or not, it is, perhaps, the dullest month of the year to the ordinary mortal, and a "betwixt-and-between" season for farmer and naturalist alike.

Nevertheless, there are things to see and hear. During the month many birds will be pairing, and some early bird song will enliven wood and hedgerow. A few over-optimistic blackbirds and thrushes will attempt nest-building and, although their time is not yet, the rooks will be taking a preliminary interest in old nesting sites.

Even thus early, not waiting for the traditional month of March, the jack hares will be going madly about their courting, putting up what to my mind is the funniest show in all creation. Not even Nervo and Knox, in their slow-motion wrestling act, are funnier than a love-stricken jack hare.

Up on the moor, in the higher reaches of the river, there are still some spawning salmon on the redds. Often I have seen them spawning in water barely deep enough to cover their dorsal fins. Back in the autumn one saw them, fresh from the sea, leaping the weir miles below, moved by that curious urge to get as far upstream as possible, some of the bigger fish disdaining the salmon ladder provided for their kind. The moor itself is bleak and sombre now; but the bobbing dipper and the lovely, trim grey wagtail—locally so aptly named the "fisherman's fairy"—are active as ever in the shallows of the river. A gaunt heron, disturbed at its fishing, rises and flaps away across the moor. A raven, homeward bound with a pouch full of food, sails high above a tor.

Insect life is not yet much in evidence, but in the home orchard the male March-moth and the curiously varied mottled-umber moth are on the wing. Should the end of the month be warm and sunny, a few queen bumble bees

may be lured too soon from hibernation; the sallow blossom is sure to attract them and any other winged insects that are out and about.

In the woods there are many snowdrops. I know of one great carpet of the lovely winter flowers, fifty yards or more in length. On the more sheltered banks there are already a few early primroses, and in the hedgerows violets. In the marsh the shrivelled clumps of the great king-ferns show no sign as yet of new year's growth, but in June or later some of them will be all of six feet tall. The bare stems of the woodland saplings have a richer look, and a seeming awareness of the new life that will soon arise in them.

F.H.L.

OFFICIALLY APPROVED INSECTICIDES AND FUNGICIDES

Since the date of the publication in the November, 1948, issue of *Agriculture* (p. 364), the following names of proprietary products have been added to the approved list under the Ministry's approval scheme.

DDT Insecticides to be used as Dusts:		
Boots DDT Dust for Horticultural Use 5% DDT	Boots Pure Drug Co. Ltd.	**AD 247**
Craven's DDT 5% Dust	W. J. Craven & Co. Ltd.	**AD 272**
ITP DDT Horticultural Powder	International Toxin Products Ltd.	**AD 297**
DDT Insecticides to be used as Sprays:		
Craven's DDT Emulsion 20%	W. J. Craven & Co. Ltd.	**AE 273**
Formaldehyde:		
PBI Formaldehyde	Pan Britannica Industries Ltd.	**AV 291**
Steriform	Pan Britannica Industries Ltd.	**AV 290**
DNC-Petroleum Oil Winter Washes:		
Ialine DNC-Petroleum Oil Winter Wash	Burt, Boulton & Haywood Ltd.	**AZ 298**
Calomel Dusts (4%):		
Craven's 4% Calomel Dust	W. J. Craven & Co. Ltd.	**BB 274**
Cyclosan	May & Baker Ltd.	**BB 288**
Metaldehyde Slug Baits:		
PBI Slug Killer	Pan Britannica Industries Ltd.	**BC 285**
Banding Greases:		
Takitak Banding Material	W. J. Craven & Co. Ltd.	**BD 275**

Products B 185 *and* O 142 *have been withdrawn from the list by the manufacturers.*

A leaflet giving the list of approved products may be obtained on application to the Ministry of Agriculture, St. Andrew's Place, Regent's Park, London, N.W.1.

Ministry of Agriculture and Fisheries, Plant Pathology Laboratory, Harpenden, Herts. January 17, 1949.

BOOK REVIEWS

Plants and Environment. R. F. DAUBENMIRE. Wiley (New York). Chapman and Hall (London). 27s

This book is better suited to the teacher of agricultural botany and crop ecology than to the farmer or advisory officer. It is in fact the outcome of the author's teaching experience since he graduated in 1935, and while attached to the Universities of Tennessee, Idaho, Minnesota, and Wyoming, and in his present post as Associate Professor of Botany at the State College of Washington.

His analysis is based on the conventional subdivision of plant ecology into autecology (the study of the interrelations between the individual and its environment) and synecology (the study of the structure, development and causes of distribution of plant communities). The modern trend towards an attempt to break down the environment into the factors of mere existence and the factors which govern morphogenesis and progress towards reproduction does not receive adequate notice.

The seven environmental factors which are given detailed analysis are soil, water, temperature, light, the atmosphere, the biotic factor, and the fire factor. These are then considered in a synthesizing chapter on the environmental complex, which leads to the concluding chapter on ecologic adaptation and evolution. The decisive effects of temperature and light in governing the degree and nature of the reproduction of species in a natural association, to which so much physiological and ecological research is at present devoted, are dealt with briefly in the chapters devoted to a general consideration of the effects of, and responses to, these two factors.

The work is a study of plant ecology rather than crop ecology, a study of plants of all types from mosses to forest trees, in their many and extremely varied natural associations as found primarily in the United States of America. In the chapter on the biotic factor, for example, the emphasis is on the academic rather than the applied and restricted aspects of the question as usually understood by a practical grassland ecologist; in addition to the effects of herbivorous animals in grazing and browsing and destroying seeds and seedlings, the author also considers carnivorous plants, pollination and dissemination by animals, lianas, epiphytes, parasitism, lichens, symbiotic nitrogen fixation, and mycotrophy.

There are 612 references to literature, "the citations being restricted to papers written in the English language in deference to students of intermediate status". There are 87 text figures of plants and associations, the latter apparently entirely from the North American vegetation.

R.O.W.

Rural Life in Northern Ireland. J. M. MOGEY. Oxford University Press. 15s.

Those interested in farming and its social aspects will find much to interest them in this book, which gives the results of a survey carried out for the Northern Ireland Council of Social Service between 1941 and 1945. Five different social regions were selected and data obtained from every household in them. The physical environment and historical setting are described, followed by an account of the occupations, incomes, population movements, kind of housing, water supply, sanitation, available transport, social activities, customs and attitudes. All this is done not by a series of statistical tables, though there is an abundance of statistical material, but by rapid sketches which, aided by well-chosen photographs, leave a clear picture in the mind. Typical farms are described with their field lay out, housing, cropping and stocking, methods of working and estimates of the gross output.

Seen through the eyes of a person accustomed to urban life, the general picture may seem more drab, perhaps, than to those who have never learned to associate happiness with plumbing. As far as farming is concerned, we are able to trace the process of amalgamation of smallholdings, the drift to the towns, the ways in which the disadvantages of the small farm are to some extent overcome, and the influence of tradition in farming methods. We even see something of the working of Young Farmers' Clubs, the ineffectual struggles of the cooperative movement, the support accorded to the Farmers' Union, and the effect of the advisory services of the Ministry of Agriculture. The handicap of inadequate housing for farm workers is well shown, and constructive criticism offered about the siting and construction of rural cottages by local authorities

If surveys of the same kind were carried out for other parts of the United Kingdom, a better basis for rural planning would be available.

It is interesting to read this book in the light of developments which have taken place since it was written, such as the raising of farm incomes due to the fixing of guaranteed prices, the increase in statutory minimum wage rates, the grants for restoring marginal lands, draining, water supplies on farms, repair and erection of farm houses and farm workers' cottages, and the rapid progress of mechanization.

V.L.

The Spread of Virus Diseases in the Potato Crop. (A. R. C. Report Series, No. 7) J. P. DONCASTER and P. H. GREGORY. H. M. Stationery Office. 5s.

Whilst it has been known for many years that the marked deterioration of potato stocks in the English lowlands was due to the rapid spread of the two aphis-borne virus diseases, Leaf-Roll and Rugose Mosaic, no intensive study of the factors underlying the spread of these virus diseases had, until recently, been carried out. This gap in our knowledge has now been partially filled by this excellent monograph. As pointed out by F. C. Bawden in the introduction, the work is in no sense a survey of the health of potato stocks but rather an epidemiological study of Leaf-Roll and Rugose Mosaic to ascertain the main factors influencing the rate of spread.

One of the interesting facts discovered was the frequent lack of proportionality between the numbers of *Myzus persicae*, the chief aphis vector, on the foliage and the amount of virus spread. In other words it was no uncommon thing to find that there was more virus spread in a light aphis infestation than in a heavy one. So that *movement* of aphides is more important than *numbers*. The occurrence of disturbing factors, possibly weather conditions, which stimulated the movement of wingless aphides from plant to plant could result in a large amount of virus transmission by relatively few aphides.

The overwintering of the aphides is an important point and it was found that fruiting peaches out-of-doors and in unheated glasshouses were the most frequent hosts on which *M. persicae* overwintered in the egg stage. In mild seasons, however, the aphis can persist, throughout the year on a succession of brassica crops, and even on sugar beet seed crops. Most of the spread of virus is by the winged aphides, their greater mobility more than compensating for their lack of numbers in comparison with the wingless aphides.

Another important conclusion is that there is a large amount of virus spread by the winged spring migrants of *M. persicae*, whereas the winged dispersal migrants are believed to play relatively little part in transmission. This fact has a direct bearing on attempts at controlling potato virus diseases in south-east England, because the spread occurs too early for roguing, early lifting or nicotine fumigation of the aphides, to be effective.

The main sources of virus infection of a potato crop are the occurrence of infected plants in the parent stock and the presence of diseased volunteer plants in the same field. Such plants are important because they are close at hand for the wingless aphides which move only short distances. Therefore, the present practice of replenishing stocks from the recognized seed-producing areas is recommended by the authors as satisfactory and economic under existing conditions. And to this the reviewer would add a word of recommendation to all those responsible for producing potato seed, to read this monograph. The amount of Leaf-Roll present this year in many of the crops produced from " new seed " should serve as a further stimulus. Besides defining and clarifying some of the problems connected with the spread of potato viruses, these studies have served to emphasize our lack of knowledge with regard to others. As suggestions for future work, the authors recommend further studies on the movements of wingless, and the flights of winged, aphis vectors and the relative importance as vectors of these two types of aphis. Further information is also needed on the problem how the aphides find their host plant and why they tend to avoid plants already heavily infested. New control measures for the aphis are needed ; also long-term field experiments to study the best rotations for eliminating volunteer potato plants, which, as already emphasized, are an important source of virus infection.

The authors of this monograph are to be heartily congratulated on a conscientious piece of work, entailing an immense amount of careful observation. The text is well written and the data clearly presented with numerous tables and graphs. No one connected with the growing of seed potatoes could do better than invest the very modest sum of five shillings in this monograph.

K. M. S.

Laboratory Manual of Elementary Botany. (Second Edition). A. W. HAUPT. McGraw-Hill. 6s. 6d.

One of the outstanding needs of students of botany, especially those who have little help for their practical work, is a simple and clear outline of what should be undertaken to supplement theoretical teaching and provide a firm foundation on which more advanced work can be built. This manual, though primarily intended for use in conjunction with the author's *Introduction to Botany*, can easily be used with any textbook.

The scheme provides for over a hundred exercises, intended for a two-year course, but all the sections can be used or omitted as required. The exercises cover a wide range, including preliminary surveys of morphology, physiology, systematic botany, angiosperms, gymnosperms, and cryptogams—in fact, almost the whole gamut of botanical study—and their form is in no way stereotyped but is suited to the subject in each case. It is to be regretted, however, that no mention is made of microchemical tests, since so much emphasis is laid on these in modern methods of teaching, even for elementary students, and it is much to be hoped that these will be included in any future edition. Special efforts are made to encourage students to think for themselves. The manual clearly explains the correct use of apparatus, especially microscopes, and also gives special instructions with regard to record-keeping by drawings and notes. On the whole the standard set is that of matriculation, but many of the exercises are appropriate to more advanced work. The book is very well printed, and should prove a great asset in this country, as well as in America.

W.E.B.

The Open Air. RICHARD JEFFERIES. Lutterworth Press. 10s. 6d.

The Open Air, the last but one of the books published during the author's lifetime, has seldom been reprinted since its first appearance in 1885. The publishers and their editor, Mr. Samuel Looker, have done well in selecting this volume for early issue in their series of reprints, for without doubt some of this writer's best work can be found in its pages.

The present issue contains the 21 original essays, together with an informative editorial introduction and some biographical and bibliographical notes by Mr. Looker, which are of more than passing interest. These essays, which are extremely varied and cover a great range of subjects, were contributed originally to several magazines and newspapers, including *Longmans Magazine* and *The Times*, during the closing years of Jefferies' life. In one or two of them we detect a nostalgic note, for the writer, now a sick man, in casting his mind back to the Wiltshire period of his life is clearly living again those sunlit days in the fields and woods around Coate. That nostalgic quality is found in the essay *Wild Flowers*, which comes very near to being Jefferies' finest piece of prose writing; here the expression is adequate to the purpose without a trace of preciosity. How clearly, too, the artist in Jefferies is revealed by the finely drawn essay *Golden Brown*. He has been to Kent and seen in the fields and orchards the strong, healthy women working at fruit-picking. He notes how the plain faces of the young women, transfigured by the glowing "golden-brown" of their sun-tanned skins, have acquired an intangible, almost matchless beauty. Himself now of feeble body, he envies the women their strong limbs and tireless bodies: "I envied them that unwearied step, that firm uprightness, and measured yet lazy gait, but most of all the power which they possessed . . . of being always in the sunlight, the air, and abroad upon the earth". Always, when I read this essay, I see a Van Gogh picture: the hues, the shapes, the song and life of birds; the glowing Kentish summer sky, the colourful apple orchards and the strong golden-brown faces of the women working in the open air; above all the sunlight, the breath of heaven, resting on it.

As with the recently published *The Old House at Coate*, this volume is graced with a number of beautifully executed wood engravings by Agnes Miller Parker. The printing, too, is of outstanding quality. This is a book to acquire and keep all the days of one's life.

A.H.H.

Printed in Great Britain under the authority of His Majesty's Stationery Office by C. Nicholls & Company Ltd., The Philips Park Press, Manchester, London and Reading.

Please mention the JOURNAL *when corresponding with Advertisers*

Please mention the JOURNAL *when corresponding with Advertisers*

Please mention the JOURNAL *when corresponding with Advertisers*

Please mention the JOURNAL *when corresponding with Advertisers*

Agriculture

PUBLISHED 6d MONTHLY

Please mention the JOURNAL *when corresponding with Advertisers*

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

Editorial Offices: St. Andrew's Place, Regent's Park, N.W.1 (*Phone: WELbeck* 7711)

VOL. LV | No. 12 | MARCH 1949

Contents

Cover Photograph

Flower picking in the Isles of Scilly .. .. *James Gibson*

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LV No. 12 MARCH 1949

OLD FARMING BELIEFS IN THE LIGHT OF SCIENCE

J. A. Scott Watson, C.B.E., LL.D.

Director-General, National Agricultural Advisory Service

OUR present-day farm practice is based partly on scientific principles, but also, and quite largely, on the body of belief that has grown out of the observation and experience of former generations of farmers. It has often happened that some new scientific finding has seemed to contradict an old tradition, and sometimes the one view, sometimes the other, has in the end prevailed. Sometimes, again, the two have eventually been reconciled; in other cases, the issue is still in dispute.

Where a contradiction seems to occur it is well to remember that our science is relatively young, that it is still far from perfect or complete, and that even the modern controlled experiment gives results that apply only to a particular soil and season. Up to the time of Liebig and Rothamsted, little more than a century back, scientists could do no more than speculate about the meaning of soil fertility, the nutrition of animals or the causes of most plant and animal diseases. Many of their theories read like nonsense today, and the books that they wrote were as likely to mislead as to help—if farmers ever read them at all. Even when properly controlled experiments began to be carried out there was a tendency to base general theories upon slender evidence.

By contrast, the craft of farming is very old. Even in our own country thinking men have been growing corn and tending livestock for thousands of years and, naturally, a vast amount of knowledge has been accumulated through their observations, successes and failures. Yet we have only to look at the methods of primitive cultivators and stockmen to see that tradition alone does not get the farmer very far.

Magic and Witchcraft Primitive men live in a world of spirits and are very apt to explain natural happenings as due to supernatural influences. Witch-doctors and other kinds of magicians enjoy large practices and can, for a suitable consideration, make rain, or supply a charm against rinderpest, or divert a swarm of locusts. Moreover it is not so long ago that our own ancestors were accustomed to burn witches and to take suitable steps to propitiate evil spirits.

One interesting example of the latter practice is described by Alexander in his entertaining little book *Notes and Sketches of Northern Rural Life.* In seventeenth century Aberdeenshire a common sight on farms was a corner of useful land left untilled and unsown and which produced an abundant crop of weeds. This patch was called "The Goodman's Acre". The "Goodman" was the Devil, and was so called in ordinary conversation because

he was much addicted to eavesdropping, and it was a matter of common prudence to avoid giving offence. It was the Devil who planted the docks, thistles, twitch and marigolds among the farmer's corn, and the best way to induce him to desist was to give him a piece of land to himself, where he could grow his own crops to his heart's content.

In those days, too, such disasters as crop failures or outbreaks of epidemic disease were either regarded as punishments by the Deity for the farmer's sins, or else were interpreted as instances of the spitefulness of persons skilled in black magic. Nannie, the witch in Burns' "Tam O'Shanter," was much given to such activities:

For mony a beast to deid she shot
And perished mony a bonny boat
And shook baith meikle corn and bere
And kept the countryside in fear.

Hence charms, to ward off the evil eye, were common. The ring-stone that often hung above the door of the cowshed in the Yorkshire dales was such a charm. The not-so-old custom of running a goat among a herd of cows, as a safeguard against abortion, is also, in all probability, a relic of superstitious belief. One suggestion is that the goat, like the ring-stone, had the power of repelling the evil eye. Another, and perhaps the most likely, is that the goat exercised the same function as the Biblical "scape-goat," i.e., was able to take upon himself the burden of human sin and to escape the consequences.

Again, most primitive peoples believe that the heavenly bodies have a profound influence on human affairs, and even today a considerable number of consulting astrologers seem to make a competence out of their business. The belief is still fairly common, especially among amateur gardeners, that the moon exercises a profound influence on the germination of seeds and the growth of seedlings; anyhow, full directions are available, in print, as to the precise phase of the moon at which particular kinds of seed should be sown; but the overwhelming burden of evidence, obtained by careful experiments, is that the phase of the moon at sowing time has no influence whatever on the success of the crop.

We have lately experienced a sort of wave of mysticism about soil fertility, e.g., about the near-magical influence of soil humus on the health of plants and animals, the supposed deleterious effects of "chemical" fertilizers, and the ritual of compost-making. On the last point, scientists can give a tolerably clear account of the process of humus formation, of how it depends on the reaction (acidity or alkalinity) of the material, and of the amount of oxygen and nutrients (particularly nitrogen and phosphates) available to the humus-forming bacteria. They can explain the origin of peat, raw humus and mild humus, and they have provided us with a material that will enable garden refuse to be turned into a useful manure. But a recent pamphlet, after condemning the use of "chemicals" (except lime), solemnly prescribes a sort of magic philtre for composting, composed of a watery extract of nettle and dandelion leaves, valerian, yarrow, oak bark, and honey.

The human mind tends to seek a logical reason for every occurrence and is reluctant to accept the fact that certain things happen by pure chance. Just as great numbers of people have spent years of their lives inventing "systems" for winning at the roulette table, so many others have, after long years of study and experiment, discovered "almost infallible" methods of controlling sex. A condensed account of these would fill a volume.

Our oldest treatise on livestock, Mascal's *Government of Cattle*, contains one of the simplest:

> If the rams be put unto the ewes when the winde bee in the North, the ewes will bring male; and if the winde bee in the South, if the ewes be then covered, they will be female lambs.

This is probably as good as any guidance that has been offered since Mascal's day.

Misinterpretations Some people are content to register observations and remember past happenings for future guidance; most, however, tend to form a theory, a satisfying explanation of the facts. Naturally, the theory is sometimes wrong.

One example is the rather widespread belief that plants, under certain conditions of environment, entirely change their character, perhaps reverting to the original wild type or turning into some other species. For instance, it is well known that, in certain parts of Russia, wheat is very apt to turn into rye; and there are parts of Scotland where cultivated oats used to turn into wild oats. Not so long ago I was told by an old farmer in the Yorkshire Wolds that he never sowed ryegrass because, in that part of the country, it commonly changed into twitch.

The explanations of these beliefs are all much the same. The seed wheat formerly used in Russia commonly contained rye as an impurity; the winters in the areas in question are very severe, and winter-killing of wheat is common; but rye is much more cold-resistant. Hence if we start with any mixture of wheat and rye, the proportion of rye will increase year by year. Similarly, wild oats are hardier and more easily grown than the general run of cultivated spring sorts; the commercial strains of ryegrass, as we know, are short-lived, especially on thin, light land upon which, incidentally, couch spreads rapidly. The outcome in each case is just what would be if the supposed transformation actually happened.

Many old remedies for animal diseases are clearly based on mistaken theories about the nature of the maladies in question. "Double Scaup" is the name given in the Yorkshire and Durham dales to a condition in which the frontal bones in the skull are very thin and weak. It occurs in hoggetts in spring, and is associated with general debility and anaemia. The old treatment, applied in spring, was to tap the skull at the weak point with a convenient stone and so crush in the bones, after which operation the condition of the sheep rapidly improved. Probably a controlled experiment would have shown that the untreated, as well as the treated, animals improved in condition with the advent of spring grass; but such a trial does not seem to have been made. In fact, as proper investigation showed, the weakness of the head bones was only one of the symptoms of a condition that was caused by stomach-worm infestation, often aggravated by malnutrition.

Until extract of male fern and carbon tetrachloride began to be used in cases of liver fluke, a common treatment was to feed as much salt as the affected animals could be induced to take. The evidence is rather conflicting as to whether this did any good, but the origin of the idea is easy to guess; sheep grazing on fresh-water marshes in autumn are very subject to fluke, while those on salt marshes keep free from trouble. An obvious explanation would be that salt was a specific cure. The fact is, of course, that the little snail which is the alternate host of the parasite happens to be a fresh-water species and does not occur on salt marshes.

Local Lore It is a wise proverb that advises the newcomer, when in doubt, to look over the hedge. It may indeed happen that the immediate neighbour is not the best schoolmaster, but at least what is accepted locally as good practice should be assumed to be such until some other can be shown to answer better.

Some thirty years ago a farmer from the uplands of the Scottish Border moved south to a farm on the chalk. The old farm, which was on cold "till" in a cool and moist climate, had been improved out of recognition by mass applications of North African phosphate. Seeing that the new farm was obviously suffering from the same trouble as the old one, the farmer ordered several wagons of the well-tried medicine and applied this at a generous rate. Just too late, a neighbour told him that African phosphate did not "answer" on the chalk, which proved to be only too true.

Another farmer, who moved from west to east, made an interesting list of the mistakes that he made in his first year in the new country, when he was too busy to seek advice. He sowed his oats at six bushels an acre and harvested them "on the green side," expecting that they would ripen in the stook, and he was ashamed to show the sample at market; he broadcast his grass seeds in May, instead of drilling them a month earlier, and they failed; he planted swedes in April and they mildewed; and so on.

But we do not realize the full value of local tradition until we see the result of attempting to farm without any. We are commonly told that soil erosion, which has ruined so much good land in the new countries, has been brought about by flagrant disregard of the rules of good husbandry. But many of the early settlers knew these rules very well—as they applied in Britain or Scandinavia—and observed them. The trouble was that methods which answered well enough in Western Europe did not answer at all in New England or Oklahoma. On the one hand, torrential rains, following periods of intense heat and drought (as they often do over a large area of the United States), can wash away vast quantities of soil from slopes that nobody in Western Europe would hesitate to cultivate and crop. On the other, great stretches of light soil, occurring on the treeless and wind-swept plains of the American West, are subject to soil blowing on a scale unimaginable by anyone whose farming experience has been confined to Western Europe.

Old and True Many old ideas, including some that have been "blown upon" by scientists, have proved, in the end, to be very well founded.

In several parts of this country there is an old tradition that crop failures can be produced by over-doses of lime. A book by an old Scottish improver, in giving an account of his work, mentions one case where "as not infrequently happens when moorish soil is well limed, the first oat crop withered away". The trouble, presumably, was manganese deficiency. Yet, until fairly recently, none of our scientists had anything to say about the risk of over-liming; indeed, since some fertile soils contain 20 per cent, or more, of calcium carbonate (i.e., 200–300 tons per acre), it seemed highly unlikely that a mere 4- or 5-ton dose could be harmful. It is only lately that the complicated business of trace elements has been cleared up.

The Rules of Good Husbandry embody a good many old ones about the rotation of crops. The rule, "white straw shall not follow white straw," which was so rigidly laid down in some districts last century, is not indeed very old; under the ancient three-field system spring cereal often followed wheat or rye. It was Coke of Norfolk and his friends who insisted on a cycle of corn—roots—corn—seeds. But the rule that wheat should not follow wheat is far older.

When the Rothamsted continuous wheat plots had been running for a dozen years or so, some people began to have their doubts about the traditional ban. Broadbalk field seemed to say that, if only the right fertilizers were applied, wheat might follow wheat as often as the farmer wished. Mr. Prout, of Sawbridgeworth in Hertfordshire, based a system of farming on wheat, wheat, and more wheat, and appeared to do very well; at any rate he suffered no obvious punishment for his sin. But later on, when the Wheat Act and the combine encouraged many to adopt the same system, it appeared that, after all, the old notion was well founded. The fact is that the soils of Rothamsted and of Prout's farm happen to be unfavourable to the fungi that cause Take-all and Eyespot which, elsewhere, can take a heavy toll of a second successive wheat crop, and can cause disaster to a third.

There are plenty of cases where farmers, by observation, found the answer to a problem without any understanding of the fundamental cause. The following quotation from Thomson's *General View of the Agriculture of the County of Fife*, written in 1800, is a case in point. The "curl" of which he speaks was a comprehensive term for the virus diseases of the potato—Leaf Roll, Mosaic, etc. :

> The Curl, a disease formerly unknown, is now become very common. There has been much speculation, and many conjectures formed, respecting the cause of this evil, and many methods proposed for prevention and remedy. It is, however, doubtful whether the real cause has yet been discovered and, consequently, whether any of the remedies proposed will prove universally successful. Of the various means of prevention that have been suggested, change of seed, especially from later and colder soils, is most generally approved of.

The growing of seed crops in upland and cool areas is the main foundation of our present plan for producing healthy seed potatoes.

English farmers discovered the value of bones, as a manure, a generation before Liebig and Lawes showed the importance of phosphate as a plant nutrient. At first, left to their own devices, farmers applied the bones as a coarse meal, or in half-inch or quarter-inch pieces ; and they used heavy dressings—a ton or two to the acre. Dairy farmers especially, like the cheesemakers of Cheshire, obtained spectacular results by this means, often doubling the product of their farms. Moreover, the effects were long lasting ; a good "boning" served for a score of years.

As the supply of bones diminished the farmer was provided with substitutes—first superphosphate and guano, and later basic slag. He was advised that these materials, being quicker acting, might be used in quite small quantities at shorter intervals, with a consequently smaller investment of capital. The fact that bone-meal continued to command a premium over these other materials was often quoted as an example of the farmer's conservatism. In the end farmers and commercial growers were obliged to accept the experts' advice, but private gardeners, being less concerned about cost, have continued to use bone-meal in preference to anything else.

Now, during these last twenty years, soil scientists have become increasingly concerned about the loss of phosphate, by fixation, when it is applied in soluble form (as superphosphate) or in the form of a very fine powder (as in slag). One recent suggestion is that the loss might be reduced by preparing phosphate fertilizers in the form of coarse granules—perhaps of about the same size as coarse bone meal.

Open Questions In this age of scientific scepticism, doubts are being cast on the efficacy of some of our oldest practices. For example, most farmers believe that the operation of summer hoeing has a beneficial effect, quite apart from its prime object of killing weeds. Gardeners

are even more insistent ; most of the popular guides to amateur gardening make statements to the effect that "the hoe is the best watering can".

In the early days of soil physics this view was endorsed by scientific writers. In tightly-packed soils with a crusted surface, water rose to the top by capillary action and was lost by evaporation ; the way to avoid such loss was to maintain a top mulch of loose dry soil, which acted like a blanket ; how wise the old cultivators must have been to think out this for themselves !

But second thoughts and further investigation have destroyed the happy concord. Laboratory experiments have shown that capillary movement of water is so very slow that the saving of moisture by hoeing (if any) must be practically negligible. Field experiments have shown that other means of weed destruction—e.g., by weed-killers—give just as good crops as clean hoeing. Moreover, hoeing may do positive harm by breaking the shallow rootlets of the crop plants. Yet the farmer still fancies that his mangolds and swedes, in a dry time, somehow look happier after the horse hoe, and the garden books still counsel us to keep on hoeing in time of drought.

The mouldboard plough, as archeologists tell us, was invented in time to reach Britain a century or so ahead of Julius Caesar, and ever since those days it has been the accepted emblem of the farmer's craft. The recent assertions that its invention was a mistake—or that, admitting that it may be inherently a useful tool, we have never learned how to use it—are therefore disconcerting in the extreme. The former assertion was made some five years ago by Mr. Faulkner in *Ploughman's Folly*. His original opinion was to the effect that farmers have been completely wasting their time and energy for two thousand years in first turning the soil upside down and, shortly afterwards, turning it downside up. But we understand that he has recently recanted—in some measure at least.

But if we accept the principle that inversion of the soil is a worthwhile operation, there still remains the question how deep to plough. There are plenty of proverbs to the effect that we should plough deep ; but generally, in practice, when we find ourselves bringing up bilious-looking clay, or paving stones, or pure chalk, we lower the land wheel. The siltland farmers, who have several feet of good earth, are tending to go deeper and deeper ; at the other extreme, on the limestone of Lincoln Heath, or on the thin chalks, the old-fashioned farmer sticks to his four or five inches, while the adventurer, often at the expense of a good deal of broken tackle, goes as deep as he can, uses a lot of fertilizer, and claims vastly better crops.

Dr. Russell's current experiments have, to date, produced very little in the way of significant results. Whenever we plough deeper than has been the custom we bring to the top material that is richer in potash, but poorer in available nitrogen and phosphate, than the original top soil. But we can adjust matters by appropriate manuring. When we have done so, in the great majority of cases there is nothing to choose between the crops produced by deep and shallow ploughing. In one or two cases, on clay land, deep ploughing has produced the better crops—probably by providing improved drainage. Contrary to the general expectation, deep ploughing —even when the immediate result was quite frightening—has not, in any case, done significant harm. It almost appears that, in the past, we have wasted a lot of breath in arguing the subject.

The moral of all this would seem to be that we can neither accept at their face value all our old beliefs, nor can we yet dispense with them and farm by the pure light of modern science. We must just go with an open mind, prepared to examine our old beliefs in the light of every new discovery.

ENSILAGE, WITH PARTICULAR REFERENCE TO THE A.I.V. PROCESS

H. E. Woodman, M.A., Ph.D., D.Sc.
School of Agriculture, University of Cambridge

THE farmer's outlook on ensilage was already changing in the years immediately preceding the war. Up to the end of the first quarter of this century, silage had never been regarded as being more than a substitute for hay in the feeding of livestock. It was usually made from fairly mature green crops, most commonly the cereal-legume mixtures; so far as grass conservation was concerned, silage-making was viewed solely as an alternative to haymaking—that is to say, as a procedure to be adopted when weather conditions made it impossible to save a hay crop. The result was that the silage of those days was never more than of medium grade as regards protein content and feeding value and, as such, was included in the class usually referred to as "maintenance fodders".

This somewhat restricted outlook began to undergo expansion round about the year 1927. By this time, the investigations of the writer and his colleagues had clearly demonstrated the protein-rich and concentrate-like character of the food material in young, leafy grass. The results suggested that if such herbage could be converted into silage of satisfactory palatability, then 22 lb. of the product, containing about 4½ lb. of dry food material, would provide all the digestible protein and starch equivalent needed for the production of a gallon of average milk. By this means, therefore, the practice of ensilage could be applied to the making of a product that could be included, as a substitute for balanced concentrates, in the production part of the winter rations of dairy cows. This naturally was regarded as an attractive proposal, since it appeared to represent an important step along the road to farm self-sufficiency.

Silage from Young Grass The first efforts of the writer, in conjunction with his colleague, Mr. Arthur Amos, to ensile such young grass did not prove very encouraging. As with other over-moist, immature green fodders, it was found that young grass, when ensiled by itself, resulted in the offensive, butyric type of silage. During the course of these investigations, however, the discovery was made that when young grass was ensiled with one-sixth of its weight of dried sugar-beet pulp, a very palatable silage, with no suggestion of the presence of the foul butyric acid, was obtained. This favourable result was attributed partly to the reduction of the moisture content of the ensiled material caused by the presence of the dried beet pulp, and partly to the fact that the beet pulp provided carbohydrate capable of undergoing fermentation with the production of the lactic acid essential to successful conservation.

It is now customary to assume that the protein-rich fodders, such as young grass and pure legumes, are relatively deficient in easily-fermentable carbohydrate, and that for this reason the production of lactic acid by bacterial fermentation is not sufficiently rapid to ensure successful preservation and the inhibition of undesirable fermentative changes. To this, however, must be added the "buffering" action of protein, which causes the rate of acidification of the ensiled fodder to be slower than with crops less rich in protein.

Molassed Silage Readers need scarcely be reminded that the difficulties associated with the satisfactory preservation of young grass and legumes were subsequently overcome by the use of molasses as an agent for controlling the fermentation. When ensiling young grass, for

example, molasses diluted with 1–2 times its volume of water is sprinkled uniformly over the successive 4-inch layers of fodder at the rate of about 1½ gallons (=20 lb.) per ton of grass. In the case of clover or lucerne, the rate may rise to about 3 gallons per ton of green crop. The sugar in the molasses encourages the activity of the lactic bacteria, giving rise to a rapid formation of the desired lactic acid and, provided the well-known rules of silage-making are carefully observed, to the production of a palatable and pleasant-smelling silage. The molassed grass silage thus obtained played an important role during the war years in the winter feeding of dairy cows, and its use for this purpose is still strongly recommended.

A.I.V. Silage The purpose of this article is not, however, to deal with the merits of molassed silage, but to recall the details of a second method for rendering possible the efficient conservation of protein-rich fodders. This second procedure was elaborated by Professor A. I. Virtanen, a continental investigator working in Helsinki, and hence became known as the A.I.V. process. It was introduced into this country before the war and, naturally, a somewhat heated controversy arose as to its merits in relation to those of the molasses method.

Comparative investigations were undertaken at a number of research centres, and reference to the results of these tests will be made later in this article. The outcome was that, after a time, enthusiasm for the Finnish process among British farmers began to show signs of waning, and ultimately the molasses process was adopted almost exclusively in this country.

Principles of the A.I.V. Process Professor Virtanen himself, in a paper read some months ago to the Royal Dublin Society,* has given an account of the investigations that led up to his new process. Apparently he first became interested in the problems of fodder conservation in 1925, having arrived at the conclusion that, despite a great deal of experimental work, there was still "no generally valid theoretical foundation for an efficient and, in every case, reliable conservation". The ideal process, according to Professor Virtanen, should enable a green fodder to be preserved with little or no chemical breakdown of the carbohydrate, protein and other constituents of the crop, since only in this way could the quality of the resultant product be assured and the losses of nutrient matter reduced to the lowest possible level. This implied the prevention of the following changes which occur normally when a green crop is ensiled :

(1) Plant cell respiratory activity, which leads to the initial self-heating of the crop and a consequent loss of nutrient, chiefly carbohydrate.
(2) Bacterial fermentation of carbohydrate, which results in the formation of organic acids, such as acetic and lactic acids, and a further loss of organic nutrient.

In addition, the ideal method should inhibit entirely the detrimental bacterial breakdown of protein, which, as in the case of the butyric type of silage, may result in the formation of ammonia and other undesirable basic substances.

After much exploratory research on a laboratory scale, Professor Virtanen came to the conclusion that the conditions essential to such an ideal process of conservation could be realized by a direct acidification of the green crop at the time of ensiling. In other words, the acid needed for the preservation of the material is added deliberately, and in the correct amount, instead

* VIRTANEN, A. I. Silage by the A.I.V. Method. *The Economic Proceedings of the Royal Dublin Society* (1947) **3**, 311.

of being allowed to arise spontaneously in the crop itself, in a more or less fortuitous manner, by the wasteful breakdown of carbohydrate. The acid to be preferred for the purpose would naturally be lactic acid, the organic acid predominating in good silage, but Professor Virtanen quickly realized that its use would be entirely uneconomic. Instead, therefore, he used a mixture of mineral acids (hydrochloric acid containing some sulphuric acid), the degree of acidification being such as to bring the *p*H* of the ensiled fodder to between 3 and 4.

The Making of A.I.V. Silage In practice, the strong mineral acid is first diluted to what is known to the chemist as "twice-normal" strength. The crop is filled into the silo in layers 4–6 inches deep, each layer being carefully spread in turn and then sprayed or sprinkled with the correct volume of acid by means of a brass pump or a *rubber* watering-can. Filling should be as continuous as possible from day to day, and it is important that the silo should be provided with an effluent for draining off the surplus liquid; otherwise the lower layers tend to become unpalatable. The amount of diluted acid to be added increases as the percentage of protein in the crop rises, but on an average about 15 gallons per ton of green crop is needed to bring the *p*H of the ensiled fodder to the desired value.

Professor Virtanen states that the losses of nutrient matter in a fodder acidified to a *p*H between 3 and 4 are as small as 1 to 2 per cent of the dry matter originally present in the green crop, provided the moisture content of the crop is low enough to preclude losses from effluent drainage. When the moisture content is as high as 80 per cent, as in young grass, the figure for the loss of dry matter rises to about 5 per cent on account of the considerable volume of effluent containing dissolved material that drains away. This represents, according to Professor Virtanen, a 10 per cent loss of feeding value. In silage with a *p*H between 4.5 and 5, the loss of nutritive value amounts to 30–35 per cent; still higher losses occur when the *p*H exceeds 5—a value that has frequently come within the experience of Professor Virtanen in dealing with silage made by the ordinary method. It is claimed that the carotene of the green crop is preserved almost entirely by means of the A.I.V. process.

Finnish Experience Nearly twenty years' experience of the process in Finland is said to have demonstrated convincingly the palatability and wholesomeness of artificially-acidified silage. An allowance of about 90 lb. per head per day of such fodder is regarded as the maximum amount that should be included in the rations of dairy cows. Analysis of the bones, teeth and tissues from the carcasses of cows that had subsisted for long periods on rations containing high proportions of A.I.V. silage revealed nothing abnormal. During the period of feeding, the lime, phosphorus and chlorine content of the animals' blood was normal. It was noted, however, that the reaction of the urine changed from alkaline to acid, but that this could be avoided if the silage received a sprinkling of ground chalk (or a mixture of chalk and carbonate of soda) before feeding. Professor Virtanen concluded that A.I.V. silage had "no harmful effects on the animals: on the contrary, the regularity of calving has been improved".

* A scale for measuring acidity. The value 7.0 indicates neutrality; lower values represent acidity, which increases as the number becomes smaller, whilst higher values indicate an alkaline reaction. The *p*H of silage can readily be checked by means of indicator papers.

Experience in Britain In view of the foregoing account, the reader may well ask why the A.I.V. process failed to establish itself as a permanent feature of British agriculture. Several reasons may be adduced to account for this. In the first place, the A.I.V. process involves practical difficulties not found in other farm operations. The mixture of acids is not pleasant to handle, and before dilution with water it may be dangerous in unskilled hands. Since the acid attacks metals, it is necessary to use watering-cans made of rubber, and the workers in and around the silo must wear protective clothing and rubber boots. Concrete silos must be given a protective coat of bituminous paint on the inside to prevent corrosion by the acid reagent. There is the further problem of calculating the correct volume of acid to be added to the ensiled crop, although experienced workers do not find this very difficult. It may be, therefore, that the A.I.V. technique is not really suited to the temperament of the British farm-worker.

Further, the results of the various investigations carried out in this country were not such as to stimulate enthusiasm for the new process. With young grass, the margin of superiority of the A.I.V. method as regards the nutrient losses during storage was not sufficiently marked to warrant the abandonment of the molasses method, with its greater degree of simplicity and safety. Moreover, the A.I.V. silage on some occasions was reported as being somewhat less palatable than the corresponding molassed fodder.

Finally, the risk of the presence of unneutralized mineral acid in the A.I.V. silage was always a source of anxiety to the stockfeeder, even though this could be obviated by adding ground chalk at the rate of 5-6 lb. per ton of silage before feeding. The use of *unneutralized* A.I.V. silage for dairy cows had been shown by Danish workers to produce many of the customary symptoms of acidosis, with resultant disadvantageous effects on health and milk yield, but it is only fair to add that extensive trials in Holland failed to confirm the Danish findings.

Rightly or wrongly, therefore, the British farmer gradually lost interest in the A.I.V. process and resorted wholly to the molasses method for conserving young grass. For this purpose, molasses has always been made available to the farmer. Only at one centre, to the writer's knowledge, has the A.I.V. process remained in continuous use, and even there solely for making sugar-beet top silage. It appears in this case that the addition of the mineral acid so controls the fermentation as to obviate the putrid smell so frequently noted when sugar-beet tops are ensiled in a clamp. The leafage retains its form and the resultant silage has not the usual "mushy" consistency. It seems fair to comment that if direct acidification enables sugar-beet top silage of satisfactory smell and consistency to be made in clamps, then the A.I.V. process is certainly not without merit.

Present Position Although Professor Virtanen's process has not succeeded in establishing itself in Britain, it has steadily gained ground on the Continent, particularly in Finland and the Scandinavian countries, where it is now the standard practice. Visitors to those countries have brought back enthusiastic accounts of the process, and have described how, in the most modern form of A.I.V. silo, both the crop and the acid are distributed by mechanical means. They are convinced that the process offers a surer guarantee of the production of silage of high quality, particularly with the protein-rich fodders, than is possible when molasses is used as the controlling agent, and that no difficulties need be

feared when feeding the silage, *provided the essential quantity of ground chalk*
bility, then 22 lb. of the product, containing about 4½ lb. of dry food mat-
It may be, therefore, that the time has arrived for a re-examination of the process by scientific workers in this country; meanwhile, it cannot be stressed too strongly that no farmer should embark on a trial of this method of ensilage without first seeking expert advice.

THE VALUATION OF DRIED GRASS

W. S. Ferguson
Jealott's Hill Research Station, Bracknell, Berks

THE need for increased production and efficient conservation of home-grown protein foods has been impressed on the farmer during and since the war. In the next few years we want even greater home production of winter protein for farm stock and, in fact, it is impossible to foresee a time when efforts in this direction can be relaxed. Grassland, properly tended, can produce more protein per acre than most other crops, but the productivity of much of our grassland is lower than it need be and steps should be taken to increase it. Increased production of herbage is, however, only part of the battle; more and better conservation of the herbage for winter feeding is also needed.

This article is concerned with one conservation product—dried grass—and its purpose is to consider, from the viewpoint of the farmer who feeds dried grass, how it is best evaluated so that it may be fed most economically and beneficially.

The variable feeding value of dried grass is fully realized by all farmers. Young grass has many valuable nutritional properties, not least that it has a high protein content; it is balanced for milk production, since it contains protein and starch equivalents in the correct ratio. But this balance is disturbed as the grass matures, the protein equivalent falling rapidly and the starch equivalent relatively slightly. In practice, a good deal of medium- and low-protein dried grass is produced in a drying season, and much of this must go to the maintenance rations of the dairy cows.

Protein for winter feeding is scarce on all farms today, and on farms fortunate enough to be able to produce dried grass steps should be taken to ensure economical use of the protein so conserved. This cannot be done unless the protein contents of the available grades of dried grass are known. It is impossible, of course, to determine in the laboratory the feeding value of all the samples of dried grass to be fed during the winter months, but enough of these determinations have been made to demonstrate marked correlations between total protein and digestible protein contents, and between protein and starch equivalent contents of dried grass. It is possible, therefore, to calculate with fair accuracy for practical purposes the protein and starch equivalents of dried grass from a determined protein content. Thus from the calculated feeding values it is simple to design rations which make full and economical use of the protein, and the following table gives an example of how dried grass may be fed efficiently provided the crude protein content is known.

Replacement Value of Dried Grass

Protein Content of Dried Grass	10 lb. Dried Grass Replaces— Concentrates		Average Meadow Hay*
per cent	*lb.*		*lb.*
15 and over	8½–9½		—
14	7	plus	4
13	5	,,	7
12	2¾	,,	10
11	1½	,,	12
10	—		14

The protein content alone does not tell us anything about the indefinable virtues of dried grass, and no analysis can supply such information, since no one can say what should be looked for. High protein content does, however, generally denote a young stage of growth of the grass dried and consequently a desirable level of these virtues.

It would appear that the present system of evaluating dried grass in terms of carotene content is based mainly on the fact that carotene, being the precursor of vitamin A, is an essential dietary constituent and that the absolute amount present in dried grass is of great importance to the well-being of all farm animals. The carotene requirements of farm animals have received considerable attention. Practically all the work has been done in America and the experiments of most significance for the present purpose are those in which the carotene requirements are based on carotene as present in dried lucerne.

Carotene Requirements of Stock CALVES. Keener *et al.* (1) concluded, from histological and liver storage studies, that 1.2 mg. carotene, as present in dried lucerne, per 100 lb. bodyweight was the minimum daily requirement of calves maintained at 50°–70°F. and that full protection against vitamin A deficiency in an average winter was obtained with 2.7 mg. Moore (2) arrived at similar figures, placing the carotene requirement at 1.1–1.6 mg. per 100 lb. bodyweight, depending on the availability of the carotene from various sources.

YOUNG STOCK. Jones *et al.* (3), using cattle varying in age from 3 to 16 months, found that 0.5 mg. carotene, in dried lucerne, per 100 lb. bodyweight per day was not sufficient to maintain satisfactory body condition. They showed the minimum requirement to be 1.5 mg. per 100 lb. bodyweight and recommended feeding 2–5 mg.

STEERS. Frey and Jensen (4) studied the rate of depletion of vitamin A reserve in the livers of steers on rations deficient in carotene, and found the decrease to be at a constant fractional rate, some 50 per cent being lost every 40 days. Guilbert and Hart (5), in a similar study, obtained no evidence of vitamin A deficiency until the cattle had been on a carotene-deficient ration for 225 days, and even after this period growth continued at the rate of 1 lb. per day. The main effect of the carotene-deficient ration appeared to be loss of appetite.

MATURE CATTLE. Guilbert and Hart (6) quote 1.1–1.5 mg. per 100 lb. bodyweight and consider that the minimum requirements of all mammals fall into this range. They demonstrated (7) that cows receiving 1 lb. daily of fairly green lucerne hay, in addition to a basic ration deficient in vitamin A and carotene, did not show clinical symptoms of vitamin deficiency even after a period seven months longer than was required to deplete similar animals on the basic ration alone. Intake was, however, below minimum, as the milk produced was very low in vitamin A.

* Starch equivalent 35; Protein equivalent 3.1.

Dann ([9]) states that the need for supplementary vitamin A is probably much greater during lactation, since the daily output in milk may reach 3,000 International Units per day. This quantity equals 1.8 mg. carotene. As the minimum daily carotene requirement of a cow weighing 1,000 lb. is 15 mg., the relative carotene requirement in milk production is obviously low.

PIGS, SHEEP AND POULTRY. These are not dealt with in detail, but the stated standards are given in the following table:

Table 1. Minimum Carotene Requirements of Farm Stock

	Carotene *mg. per* 100 *lb. bodyweight daily*	*mg. per lb. food*	Reference
Sheep	1.1–1.6*		8
Cattle			
All Classes	1.5*		3
All Classes	1.1–1.5*		8
Calves	1.2*		1
Calves	1.1–1.6		2
Pigs	1.1–1.8		8
Poultry			
Birth to 12 weeks	0.8	0.8*	9
12 weeks to maturity	0.5	0.9*	9
Laying hens	—	2.3*	9

To obtain significant *storage* of vitamin in the liver, the feeding of 5–10 times the minimum quantities is recommended in practice as far as sheep, cattle and pigs are concerned, but the above-mentioned quantities proved satisfactory for poultry.

Practical Importance of Carotene During the winter feeding period there is little point in building up any store of vitamin since the animals begin the winter with a reserve and will soon build it up again when turned out to grass in the spring. It is logical, therefore, to assume that only a little more than the minimum quantity of carotene need be fed in the winter months; an allowance of five times the minimum would allow an ample safety margin.

Using five times the minimum carotene requirements per lb. bodyweight, the total daily carotene requirements of cattle of varying sizes can be calculated. The figures are given in Table 2, together with the quantities of dried grass needed to supply the carotene. For this purpose the carotene content of the dried grass has been taken as 20 mg. per cent, i.e., grass of very moderate quality. The carotene requirements quoted in this table compare favourably with those recently recommended by F.A.O. ([10]).

Table 2. Daily Carotene Requirements (minimum x 5) of Cattle, and Quantities of Dried Grass Needed to Supply Them

Live Weight	Daily Carotene Requirement	Dried Grass Supplying Carotene		
lb.	*mg.*	*grm.*		*lb.*
200	11-15	75	=	0.17
600	33-45	225	=	0.50
1,000	55-75	375	=	0.83
1,200	66-90	450	=	1.00

It will be seen that 1 lb. of dried grass of only moderate carotene content supplies sufficient carotene for fully-grown cattle. If dried grass is available on a farm it will certainly be fed far above this level, and therefore the quantity of carotene in the dried grass appears immaterial.

* Carotene as present in dried lucerne.

A point worth stressing again is that cattle will normally begin the winter feeding period with a large store of vitamin A in the liver and this will be depleted by only about 50 per cent after 40 days on a *carotene-deficient diet.* After 120 days the store of vitamin A might still be some 10 per cent of its original value, so that the animal would still have sufficient vitamin for its needs. The colour of the milk is affected earlier, since carotene disappears from the liver before the liver vitamin A level is seriously affected.

It appears, therefore, that cows can pass the winter period on a ration very low in carotene without feeling any effects of vitamin-deficiency, although milk colour will fall markedly. These facts are amply verified by present-day feeding practices, when in many cases the only carotene supplied comes from hay which contains almost negligible quantities (0–5 mg. per cent, average 1.4 mg. per cent). Most farms today manage to feed some carotene-rich foods, e.g., winter grass or kale, up to Christmas so that any potential deficiency period is reduced to some three months.

A brief reference may be made to pigs. These animals have about the same carotene requirements per unit bodyweight as cattle, and the requirements of pigs weighing 100 and 200 lb. would be met by 40 and 80 grm. respectively of the dried grass referred to in Table 2. These figures are well within the limit of dried grass which can be fed in pig rations, namely, 10–15 per cent.

As regards poultry, the figures quoted in Table 1 represent satisfactory levels of carotene in the rations. Laying hens have the highest carotene requirement, namely 2.3 mg. per lb. food. If 10 per cent of a dried grass containing 20 mg. per cent carotene is included in a poultry feed, it will supply 9 mg. carotene per lb. food, or 4 times the requirements, presuming that no loss of carotene occurs during storage. The information available on this point is scanty but will be considered later.

It would appear that poultry feeds containing 10 per cent dried grass of reasonable quality contain ample carotene ; even if only 5 per cent dried grass is included, there is still an appreciable safety margin. The inclusion in the poultry feed of 10 per cent and 5 per cent poor quality dried grass containing only 10 mg. per cent carotene would supply 4.5 and 2.25 mg. carotene per lb. food respectively. The addition of only 5 per cent dried grass would just satisfy the requirements, but in this case losses of carotene during storage of the mixed feed might be important.

In general, it seems that the valuation of dried grass for poultry rations on the carotene basis is not necessary. When storage conditions are poor and result in losses of carotene, dried grass of high carotene content when purchased would have to be used as an insurance. In all the above considerations the controversial question of the relative biological values of the numerous carotene isomers does not arise, since most of the carotene requirements are based on carotene as present in dried lucerne, which is similar to dried grass.

Carotene and Vitamin A Contents of Milk and Butter The carotene and vitamin A contents of milk are dependent upon the concentrations of these substances in the blood, and the latter concentrations are, in turn, dependent on the reserves in the liver. On carotene-deficient rations the liver store of carotene is depleted more quickly than that of vitamin A, and under these conditions the yellow colour and carotene content of milk is, therefore, more markedly reduced than the vitamin A content. For example, in an experiment at Jealott's Hill, cows were fed a normal winter ration deficient in carotene ; the yellow colour of the butter fell from 7.4 yellow units to 0.7

yellow units in four months, whereas the vitamin A content fell only from 0.68 to 0.32 mg. per cent. In this experiment another group of cows was fed poor quality stack silage; the yellow colour of the butter of these cows fell 50 per cent in four months, but the vitamin A content remained unchanged.

A pale winter milk or butter does not, therefore, necessarily denote a deficiency of vitamin A, although the biological value due to vitamin A and carotene must be less than in coloured milk. The desirability of raising the vitamin content of winter milk for human needs is outside the scope of this note; the farmer at present derives no financial benefit from supplying such milk.

Experiments were made at Jealott's Hill to see how much dried grass need be fed to raise the yellow colour of butter to about the summer level. Additions of 1½ and 3 lb. good quality dried grass to winter rations of cows produced no increase in yellow colour, but 7¾ lb. gave a very beneficial effect. From other experiments with silage it has been concluded that 5 lb. of dry matter of conserved young herbage will yield a noticeable improvement in the colour of winter butter. Workers in Denmark have shown that improvements in methods of haymaking produce hay which can raise the total vitamin activity of winter butter markedly, and that 1–2 lb. artificially dried grass also effects an improvement.

The Effect of Storage on the Carotene Content of Dried Grass

The information available on the loss of carotene during storage of dried grass is scanty, particularly regarding baled dried grass. Most of the work in this field has been carried out on dried lucerne, but presumably the main findings can be applied to dried grass.

The losses of carotene in lucerne are due to oxidation and enzyme action, although there is some evidence that the latter is of less importance in grasses ([11]). Oxygen supply and temperature are the two factors mainly concerned in the loss of carotene from dried grass, and high-pressure baling of long material, causing fairly efficient exclusion of air, is more effective in preventing carotene loss than normal storage of ground material. Several workers have found that the loss of carotene is much greater than the loss of green colour.

The following table summarizes storage experiments carried out on dried lucerne meal.

Method of Storage	Length of Time *months*	Temperature *degrees Fahr.*	Loss of Carotene *per cent*	Reference
Loose	4	—	60	12
Compressed..	4	—	62	12
In jute sacks	6	warm room	80	13
In burlap or paper bags ..	6	—23	10	14
,, ,, ,,	6	—10	14	14
,, ,, ,,	12	—10	30	14
,, ,, ,,	6	1–6	50	14
,, ,, ,,	12	outdoors	60	14
Closed glass containers ..	up to 112 days	40 with low O_2	slight	15
—	3 months (summer)	—	40	16

It will be seen that the loss of carotene can be very considerable under conditions of normal storage. Hoffman *et al.* ([15]) consider that little loss of carotene will arise if the oxygen content of the meal is about 3 per cent at the beginning of storage.

Davis ([17]) investigated the effect of heat on the carotene content of dried lucerne stored in paper bags. The meal was packed into bags at a temperature of over 90°F. and the bags were stacked. Eight months later it was found that the bags on the outside of the stack had lost 15–40 per cent carotene, and those inside, 50–70 per cent. Two bags which were cooled quickly and not stacked lost rather less—between 19 and 30 per cent. In a further test, lucerne bagged at 65°–70°F. lost 22 per cent carotene in 17 days and there was no further loss up to 3 months.

In view of the large losses of carotene which can obviously take place under ordinary storage conditions, it appears that valuation of dried grass on carotene content *determined immediately after drying* might lead to many injustices. It is hoped that the evidence produced is sufficient to show that the valuation on carotene content is unjustified and that a change to protein valuation, which would enable the farmer to feed the material wisely and economically, is wholly desirable.

References

1. Keener *et al.* *J. Dairy Sci.* (1942) **25**, 571.
2. Moore. *J. Dairy Sci.* (1939) **22**, 803.
3. Jones *et al.* *Texas Agric. Expt. Sta. Bull.* 630 (1943).
4. Frey and Jensen. *J. Nutrit.* (1946) **32**, 133.
5. Guilbert and Hart. *J. Nutrit.* (1934) **8**, 25.
6. Guilbert and Hart. *J. Nutrit.* (1940) **19**, 91.
7. Guilbert and Hart. *J. Nutrit.* (1935) **10**, 409.
8. Dann. *Biochem. J.* (1936) **30**, 1644.
9. Sherwood and Fraps. *Texas Agric. Expt. Sta. Bull.* 583 (1940).
10. Allman and Hamilton. *F.A.O. Agric. Studies No.* 5 (1948).
11. Bolin. *J. Dairy Sci.* (1939) **22**, 11.
12. Brunius and Hellström. *Svensk. Kem. Tid.* (1945) **57**, 86.
13. Record *et al.* *Ohio Agric. Expt. Sta. Bull.* 579 (1937).
14. Wilder and Bethke. *Poult. Sci.* (1941) **20**, 304.
15. Hoffman *et al.* *J. Agric. Res.* (1945) **71**, 361.
16. Fraps and Kemmerer. *Texas Agric. Expt. Sta. Bull.* 557 (1937).
17. Davies. *Fert. and Feeding Stuffs J.* (1942) **28**, 119.

KERSEY WHITE

A NEW STRAIN OF WHITE CLOVER

G. E. Barrows

Polstead, Colchester

THE original plant of "Kersey white" was discovered in 1924 growing in a crop of lucerne at Mr. E. F. Gooding's Red House Farm, Witnesham, Suffolk. In that year a "runner" was taken by Mr. Everett Partridge and planted in his garden at West Sampsons Hall, Kersey. This plant was multiplied vegetatively for three years ; by 1927 the increase was sufficient to transplant one acre, and from this acre seed was obtained for trial leys. In general, the strain is not unlike that of the best New Zealand stocks, in so far as robustness of growth, etc. is concerned, yet there is some evidence to show that it has a greater spreading capacity.

KERSEY WHITE

I first saw Kersey white clover in the observation plots at the National Institute of Agricultural Botany, Cambridge in 1945 and was impressed by its size and vigorous appearance. Shortly afterwards I was shown one of the trial leys at Kersey, in which this strain was still making a valuable contribution to the sward. This ley was put down in 1939 with a mixture consisting of 12 lb. Italian ryegrass, 12 lb. perennial ryegrass, 4 lb. broad red clover, 4 lb. trefoil, and 2 lb. Kersey white clover (second generation).

In 1946 Mr. Partridge, convinced that this strain was a valuable addition to the existing range of white clovers, offered the first stock for multiplication to the West Suffolk Seed Growers' Specialist Branch of the National Farmers' Union, of which branch he is a member. In handing over the stock (third generation seed from the 1939 ley previously mentioned) he stipulated that the branch should, after satisfying itself as to the merits of this strain, make it available to the farming community as soon as practicable. The branch accordingly placed 24½ acres of the clover on members' farms for trial ; seed was sown in 1946 on 10 acres at Rickinghall, 10 acres at Welnetham, and 4½ acres at Polstead.

At Rickinghall, where the crop was grazed into May, 1947, aftermath was considered to be rather short for easy harvesting. Yield was about 154 lb. per acre. At Welnetham the crop was sheep fed until May 18, grazing being very severe ; recovery was rapid. The seed crop was cut by binder but not tied, and the aftermath again held sheep. The yield was about 120 lb. per acre.

At Polstead the seed had to be undersown. 4 lb. of Kersey white was sown along with 7 lb. of S.23 perennial ryegrass per acre, in a crop of Star oats which was rather badly laid. The crop grew rapidly in the wet weather after harvest and was some 8 inches high when the severe weather began. The bare patches filled up in spring and, owing to the vigorous growth of the clover, the ryegrass was almost completely suppressed. The crop received no manurial treatment in 1947 and was neither grazed nor cut. The resultant crop was very bulky, being about fifteen inches high at flowering. Yield was 116 lb. of seed per acre, with a purity of 95.3 per cent.

Although it is far too early to generalize, the following points about Kersey white appear significant :

(a) Its ability to spread ; the stolons are thick and coarse, but root freely at the internodes.

(b) Its rapid recovery after defoliation ; this was noticed in two out of the three crops, despite severe drought. When the crop at Polstead was fit to cart, the aftermath was growing through the swath.

(c) Its persistency, as shown in the 1939 ley at Kersey.

It would seem that this strain merits extensive trial as an ingredient of ley mixtures, notably those intended to remain down for three years or longer. It is markedly winter-green, recovers quickly after grazing and, since it attains a convenient height for handling early in the season, appears to have possibilities for silage-making and drying. In early April last year my crop averaged 7 inches high and in May, when cut for silage, gave a yield of just under 3 tons per acre.

"AGRICULTURE" INDEX

The Index to Volume LV will be issued with the April number.

PHOSPHATE RECOVERY BY CROPS

F. HANLEY, M.A.
School of Agriculture, Cambridge

WHILST considerable amounts of lime and nitrogen are removed from soils in drainage water, potash and phosphate are not commonly lost in this way except in very small amounts, even when applied in water-soluble forms. In the case of phosphate, the reason for this is that water-soluble phosphates, such as the phosphate in superphosphate and ammonium phosphate, are changed in the soil into forms which are less easily dissolved and therefore less likely to be washed out in the drainage. Some of these forms of soil phosphate, though only slightly soluble in water, are nevertheless readily available to plants, but others are completely unavailable and may remain so for a very long time. Hence, although this conversion of soluble phosphate into more inert forms prevents loss in drainage, it may lead to a very low recovery of phosphate in the crop if the new form of phosphate is of a type that is not available to plants.

Insoluble phosphates may also undergo changes in the soil, depending on their type and the soil conditions. Some types, e.g., the phosphate in ground mineral phosphate, are both insoluble in water and only very slowly available to plants. Such phosphates may remain in the soil, unchanged, for a long time, or they may slowly change into still less available forms. In acid soils they may slowly break down into forms which, though available to plants, are also liable to fixation again as unavailable phosphate. Other relatively insoluble types of phosphate, e.g., the so-called reverted phosphates, may be readily available to plants despite their low solubility. Even these types, however, do not retain their availability indefinitely but slowly change in the soil into types that are both insoluble in water and unavailable to plants.

This conversion of available phosphate into more inert forms has become known as "phosphate fixation" and presents an important problem in the efficient use of phosphate fertilizers.

Although as much as 25 per cent of the phosphate applied to grassland is sometimes recovered in the herbage over a period of years, the average rate of recovery is probably no more than 20 per cent and may often fall below this figure. Arable crops, in general, show no better recovery than grassland. There is sound evidence that in some soils from 80 to 90 per cent of applied phosphate may be fixed or locked up in the soil in forms that are completely useless to the plant, and may remain so almost indefinitely.

It is interesting to note here that recovery of nitrogen and potash, applied as fertilizer, is much more satisfactory, though still only about 50 per cent of the amount applied.

Fixation The term "phosphate fixation" is generally applied to the conversion by soils of available forms of phosphate, especially water-soluble phosphate, into relatively unavailable forms. The way in which this happens depends on the fertilizer, the nature of the soil, and its reaction or lime status. In a soil that is neutral or only slightly acid, water-soluble phosphate generally reacts with soil calcium to form a type of calcium phosphate which is only slightly soluble in water but is nevertheless readily available to plants. Whilst in solution the phosphate will be well distributed throughout the layer of soil to which it has been applied, and the new type of phosphate, when formed, will therefore be well distributed in that layer. This new form of phosphate, being only slightly soluble, will not wash out in the drainage to any extent and will often remain in the soil in an available form for a considerable time.

This type of fixation is not usually a serious disadvantage. Indeed, by protecting the phosphate from loss by leaching, it may reduce wastage. Its greatest drawback is, perhaps, that conversion from the water-soluble to the less soluble form may occur before the phosphate has had time to penetrate to any appreciable depth in the soil. In such circumstances, unless the fertilizer was originally "placed" at some depth in the soil, or was worked in by thorough cultivations immediately after application, the phosphate may remain in the top inch or so of soil, where it will be accessible to only a small proportion of plant roots. This is likely to happen when phosphate is applied to the surface of grassland.

In contact with alkaline, calcareous soils, water-soluble phosphate is soon converted into insoluble forms that are almost unavailable to plants and are likely to remain so for a long time. This type of fixation is obviously likely to lead to very low recovery of phosphate. In extreme cases it may result in crop growth being restricted by phosphate deficiency, despite an application of phosphate fertilizer to the crop. The only practicable way of delaying this conversion of water-soluble phosphate to an inert form in such soils seems to be to apply the phosphate fertilizer in such a way that some, at least, is protected from immediate contact with the soil; the methods will be discussed later.

In very acid soils water-soluble phosphate is quickly fixed as insoluble compounds of iron and aluminium, almost completely unavailable to plants, and on acid clay soils some may also be taken up by the clay colloids to form almost equally useless complexes. Serious phosphate fixation is, therefore, very common on acid soils, and particularly important on acid clay soils where it may sometimes reduce the recovery of added phosphate to as little as 10 per cent. If lime or chalk is applied to such soils in the amounts needed to bring them back to a neutral or only slightly acid condition before the soluble phosphate fertilizer is applied, phosphate fixation will obviously be a much less serious problem.

Increasing Recovery of Phosphate: Liming and Type of Fertilizer It is clear from what has already been said that any attempt to increase the recovery of added phosphate from the soil must depend on the method of fixation in each case, the extent to which there is free choice of fertilizer material, and the method and time of application.

In acid soils, the first and most important step is to neutralize the acidity by the application of the correct amount of some suitable form of lime or chalk. Subsequent applications of water-soluble phosphate will then be converted first into forms less soluble but still readily available to crops and only later, and relatively slowly, into unavailable forms. Similarly, forms that are only slightly soluble but still readily available will be likely to remain available for a longer period if the soil is neutral or only very slightly acid. In this way several successive crops may benefit from a single application of phosphate, and the total recovery of phosphate may rise correspondingly.

The suitability of a fertilizer to soil and crop will have some influence on phosphate recovery. On neutral and alkaline soils, especially under low rainfall, ground mineral phosphate and basic slags of low citric-solubility are not likely to be effective and should not generally be used. Recovery of phosphate from these fertilizers will be very low in such circumstances, and it will be more satisfactory to use water-soluble phosphate as in superphosphate and ammonium phosphate. Alternatively, basic slag of high citric-solubility may be used, for this usually breaks down fairly quickly in

moist soil to produce soluble phosphate which will behave very like the phosphate in superphosphate.

Reverted phosphates might also be very suitable in these circumstances. This type of phosphate is made by adding certain materials to superphosphate to convert it into a form of phosphate which, though only slightly soluble in water, is still readily available to plants. An example of this is the so-called Serpentine Superphosphate, which was used extensively in New Zealand during the war. The use of these reverted phosphates has not developed to any extent in Britain as yet, possibly because of the very great importance still attached by some people to water-solubility as the best indication of the value of a phosphatic fertilizer (as distinct from solubility in other weak solvents like the ammonium citrate test used in some countries). As these reverted phosphates are only slightly soluble in water whilst being still available to plants, their possible value as a means of reducing wastage by fixation and yet maintaining a good supply of phosphate in a form available to the plant seems worthy of further investigation.

Ground mineral phosphate and basic slags of low citric-solubility are often satisfactory on acid soils, especially for grassland and turnips in a wet district. In these circumstances they are slowly broken down by soil acids to more available forms of phosphate and, over a period of years, may show as good a recovery of phosphate as any other phosphatic fertilizer.

Time of Application of Fertilizer The time of application of the phosphate fertilizer may, in the long run, be one of the most important factors in determining percentage recovery. It has already been explained that on soils which are neutral or only slightly acid, phosphate is converted into a form which, though only slightly soluble, may remain readily available to plants long after application. On such soils an application of phosphate exceeding the requirements of the crop to which it is applied may leave behind phosphate residues in forms available to the following crop or crops, though a proportion of the phosphate will usually turn into less available forms and remain unused in the soil.

On soils of high fixing power, however, where soluble phosphate is rapidly combined with iron, aluminium or clay complexes, or converted into unavailable calcium compounds, water-soluble phosphate is likely to remain in an available form for only a short time after application. In such circumstances very little, if any, phosphate is likely to remain in an available form after the season in which it is applied. One way to reduce the high rate of loss by fixation on such soils is to use only sufficient phosphate fertilizer to meet the needs of the crop to which it is applied, making further small applications for each subsequent crop. This is better than attempting to cover the needs for two or three years by giving a dressing to the first crop far in excess of its requirements and relying on subsequent crops to get their supplies from the residue.

This hand-to-mouth procedure conflicts with the views of those who like to build up and maintain a good reserve of available plant food in the soil. To attempt to build up such a reserve in a soil of high fixing power, where fixation is in the form of very inert and unavailable compounds, is, however, futile and wasteful, unless first something is done to reduce the fixing power of the soil, e.g., by liming, in the case of an acid soil.

Concentration and Condition of Fertilizer Where phosphate fertilizer is concentrated in bands or layers in the soil, as by a combined seed and fertilizer drill, some of the fertilizer may not be in close contact with the soil, and the concentration of phosphate in the immediate vicinity of the band or layer

may be too great for complete fixation to take place. In such cases a supply of phosphate in the form in which it was applied may persist in these layers for a considerable time after application. This may enable plants to take up more of the phosphate until subsequent cultivations destroy the concentration of fertilizer by mixing it with the surrounding soil.

The physical condition of the fertilizer has an obvious bearing on the rapidity and extent of fixation. A fine powder is likely to become mixed more intimately with the soil than would granules or pellets, and hence is likely to undergo more rapid and complete fixation. Material in the form of a fine powder is also likely to be dissolved more quickly, and consequently more rapidly "fixed," than the same material in larger granules, since it exposes a greater surface to solvent action. On soils of high fixing power, therefore, where fixation occurs as unavailable forms of phosphate, it seems likely that granular forms of water-soluble phosphate fertilizer may give a greater recovery of added phosphate than fine powders. This, however, does not alter the fact that insoluble materials of the mineral phosphate type should always be finely ground.

Trials have been made in some countries with fertilizers applied in the form of "briquettes" and "nests" much larger than ordinary granules. Good results have been reported in a few cases, but the method has never spread and there seem to be no published results from trials in this country, if indeed any such trials have been made.

Soaking the seed in a solution of phosphate before planting has been shown to increase the recovery of phosphate to a very high level. Unfortunately, any treatment that involves soaking seed is both laborious and difficult to carry out without grave risk of injury to germination and, for farm crops at any rate, is probably not worth further consideration at present.

Mixing with farmyard manure seemed to increase recovery of phosphate from superphosphate in trials in Sweden and America. Presumably the phosphate was converted by the bases in the manure into a less soluble, but readily available, form of phosphate. Mixing with farmyard manure may also both prevent the fertilizer coming into such close contact with the soil and also concentrate it in zones or pockets to some extent. The decomposition of the organic matter of the manure by soil micro-organisms would also liberate a good deal of carbon dioxide which would increase the availability of the phosphate.

Broadcasting fertilizer over the ridges before planting potatoes is known to be more efficient than working the fertilizer into the soil before ridging. Where dung is applied in the ridges it seems, therefore, even more desirable to apply the fertilizer over the ridges, on top of the dung if possible.

Ploughing in the fertilizer and placing it in the bottom of the plough furrow have also been suggested as ways of increasing the efficiency of phosphate fertilizer, since both these methods tend to concentrate the fertilizer in layers as well as ensuring that it lies in the region where root development is likely to be extensive. It is too early to say how successful these methods of application are likely to be in this country.

Soil Micro-Organisms In connection with the possible influence of soil micro-organisms on the availability of soil phosphate, it is interesting to note that in recent pot-culture experiments in France, reported by F. C. Gerretsen, soil micro-organisms increased the uptake of phosphate by the roots of plants in their immediate neighbourhood. If field experiments confirm this result, it will constitute an additional

reason for emphasizing the importance of maintaining the soil in a condition favourable to the activity of these organisms and for suggesting that proper aeration, good drainage and good tilth may also help to improve the recovery of phosphate.

Expenditure on phosphate fertilizers in the United Kingdom is now some £12 million annually. The present low phosphate recovery rates constitute a serious financial loss. Attention to the factors that lead to rapid and serious fixation and to the suggestions made for delaying or reducing fixation in various circumstances would often lead to more efficient use of phosphate fertilizer and a corresponding reduction in the amounts required to maintain crop yields.

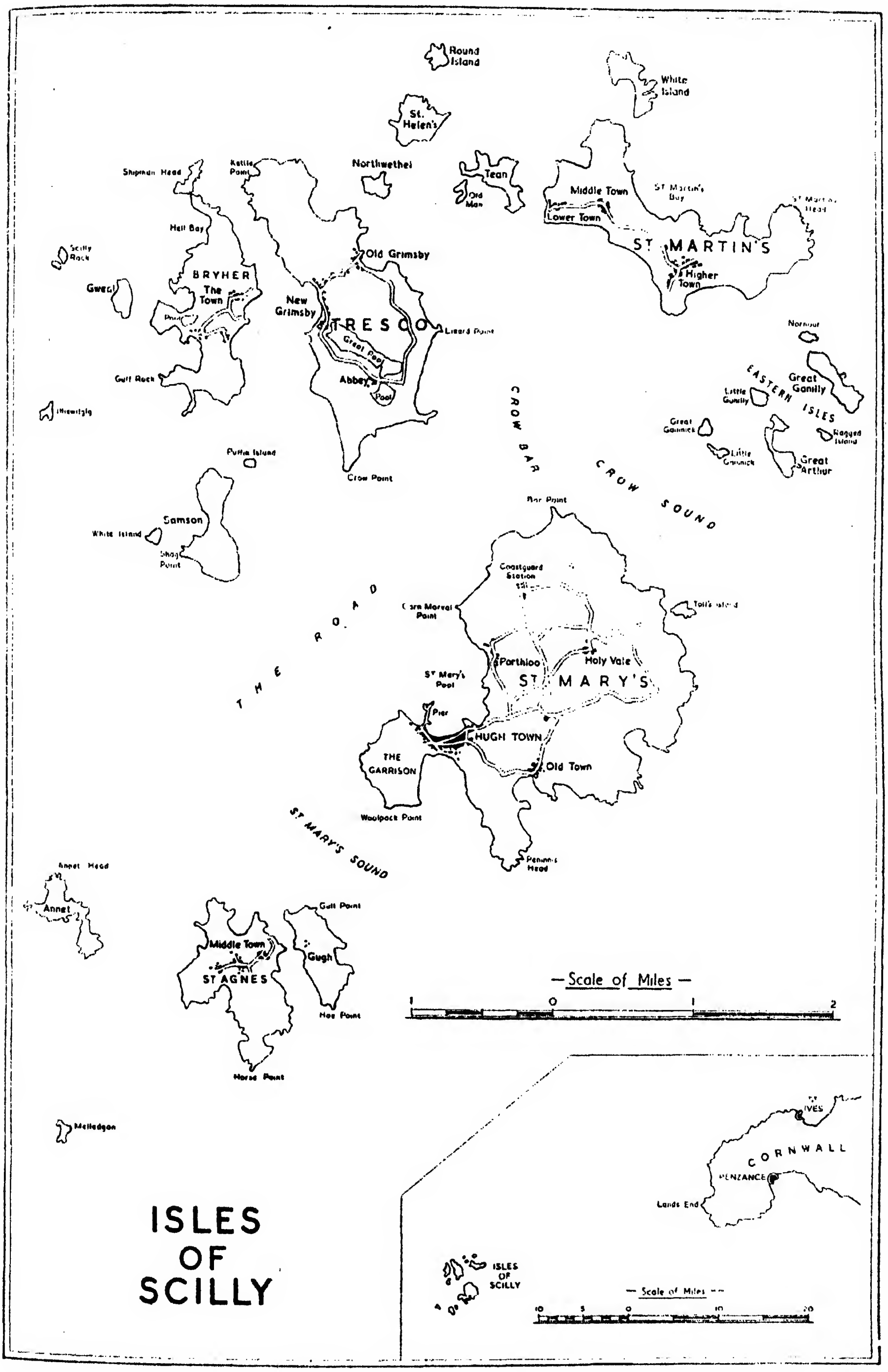
AGRICULTURE IN THE ISLES OF SCILLY

F. W. SHEPHERD, N.D.H. (Hons.)
County Agricultural Officer, Isles of Scilly

SMALL, and set as they are in the Atlantic Ocean, it is perhaps not surprising that the Isles of Scilly are unknown to many people and confused with more remote islands by others. They are, of course, part of the British Isles ; the granite of which they are formed is similar to the rocky headlands of West Cornwall, and the climate is rather milder than that experienced in the Penzance area. The whole group of about a hundred rocks and islands is scattered over an area some twelve miles by six, and about twenty-five miles of sea separate them from Land's End. Although there are many steep cliffs the heights are not great and no point is as much as 200 feet above sea level ; the low elevation exposes the islands to strong winds and probably accounts for the lower rainfall which, at 32 inches a year, is less than that in many parts of Cornwall, where averages of over 40 inches are usual.

Of the five inhabited islands, St. Mary's is the largest, with 1,865 of the total of 6,000 acres and well over half of the whole population of 1,700. It is on this island that the B.E.A. land their planes and at which the Islands' steamer loads and discharges its cargo. Passengers and cargo for the other islands must travel the two or three miles by small launch—quite a serious undertaking when flowers and potatoes are being sent to the mainland and bread and coal, meat and paraffin, cattle food and groceries, are needed by the "off" islanders.

For many years the population has been dwindling. In the past the inhabitants supported themselves by kelp burning, shipbuilding and manning those ships, by fishing and piloting, and perhaps supplemented their lawful earnings by a little smuggling and wrecking, for many ships have gone aground on the rocky coasts. Farming then was, no doubt, of a subsistence nature, with early potatoes and vegetables for visiting ships providing the first cash crops to be grown. When, in 1870, a single box of narcissus flowers realized a satisfactory price in London, a new source of income was opened up, and the industry thus started has since become the mainstay of the Islands.


Round Island
White Island
St. Helen's
Northwethel
Tean
Old Man
Middle Town
Lower Town
ST MARTIN'S
Higher Town
Shipman Head
Kettle Point
Hell Bay
Scilly Rock
BRYHER
The Town
Gweal
Old Grimsby
New Grimsby
TRESCO
Great Pool
Abbey
Pool
Gull Rock
Puffin Island
Crow Point
CROW BAR
CROW SOUND
Great Ganilly
Little Ganilly
EASTERN ISLES
Great Arthur
Bar Point
Samson
White Island
Shag Point
THE ROAD
Coastguard Station
Carn Morval Point
Porthloo
Holy Vale
St Mary's Pool
ST MARY'S
Pier
HUGH TOWN
THE GARRISON
Old Town
Woolpack Point
ST MARY'S SOUND
Peninnis Head
Annet Head
Annet
Gull Point
Middle Town
Gugh
ST AGNES
Hoe Point
Horse Point
Melledgan
—Scale of Miles —
1 0 1 2
ISLES OF SCILLY
ST IVES
CORNWALL
PENZANCE
Lands End
ISLES OF SCILLY
— Scale of Miles —
10 5 0 10 20

The land and climate of the Isles of Scilly suit the bulbs, and the farmers depend almost entirely on the sale of flowers for their living. The soils, being derived from a granite rock, are all light in texture, varying from coarse-grained sands where the land has been built up as sand dunes to light loams on certain of the higher areas and where fine sand and humus have been washed into the low island valleys. All are naturally deficient in lime and phosphates and with persistent cultivation soon become short of organic matter. This is replaced by hauling seaweed which washes into the beaches after strong winds, by applying "pile dung" made from seaweed and weeds, by the use of the small supplies of manure from the cattle and, to a certain extent, by sowing and ploughing-in temporary leys and other green crops.

Small Farms and Fields Both farms and fields are small, the holdings varying from one of 120 acres, which is three times as large as any other and makes use of most of the available land on one island, to small gardens of a few rods. All are used to produce flowers for markets on the mainland. A few of the farmers hold their land on lease from the Duchy of Cornwall (the sole landlords), but most of them have succeeded their fathers and grandfathers in holdings which have annual tenancies; in many cases the houses and buildings belong to the tenants, although they still have only these annual agreements.

A typical large farm of 30 acres, employing three or four men, has about 15 acres under grass, 3 or 4 acres for potatoes and a similar area for fodder roots, possibly a small piece of oats which is cut half ripe for cattle food, a very few vegetables and such flowers as stocks, wallflowers and calendulas; the remaining 6 or 8 acres are bulbs. Some of the grass fields also produce narcissus in season, the variety Princeps in particular being so accommodating that its flowers can be picked in late February or early March. Its dying leaves are then cut with the grass for hay and the field grazed until the New Year, when the bulb leaves begin to grow again. Unfortunately this is not one of the best of flowers, and in times of glut it used to sell at prices which barely covered the cost of transport.

On the smaller holdings the proportion of flowers and potatoes is higher, but nearly everybody with more than 8 or 10 acres tries to keep a cow or two; the larger men milk six or eight. Cow-keeping is at once desirable and almost an obligation to the community, for there are times when those who produce for sale can barely supply the needs of the non-farmers and the many visitors.

The small fields of 1 or 2 acres are nearly all surrounded by stone hedges 4 to 6 feet high, either double thickness and filled with rubble or single and composed of large and medium-sized pieces without soil or any form of packing. Many of the fields are protected still further by living fences, and are also divided into "squares" by similar rows of plants. Common elm was probably the first to be planted for this purpose, but it quickly gets out of hand and its long roots hinder cultivations and the growth of crops. Evergreen plants have been used for many years, and today the majority of fences are of *Euonymus japonicus*, *Pittosporum crassifolium* and closely related species, *Escallonia macrantha*, and *Veronica speciosa*. Some *Brachyglottis repanda*, *Tamarix gallica* and *Olearia Traversi* are also to be found. These shelter fences are of vital importance, as the salt-laden gales can completely ruin the opening flowers and potato leaves can be blackened as if by frost. The shrubs themselves are better for some protection when first planted. This may be obtained by placing them against a stone hedge or by erecting temporary fences of wooden battens, reeds and coir or wire netting. These fences are trimmed annually, the tops, which are 8-12 feet

high, being reached by standing on a cart or, less commonly, by ladders. The trimmings of *Euonymus* in particular are fed to cattle during dry or cold weather when grass is scarce: they are said to improve the cream line on the milk. Additional protection is provided on two of the islands by belts of *Pinus insignis*, which grows well, and, to a lesser extent, by a few large specimens of *Cupressus macrocarpa* and the common elm.

Narcissus Flowers There are many varieties of narcissus, and the search for new ones goes on continually. Some farmers buy a few bulbs of new kinds for trial each year. There are, however, several tried and well-known varieties which are widely grown. The first to be picked, usually in November, is Paper White; it is closely followed by Soleil d'Or, a variety with several cheerful rich orange and yellow flowers on a single stem. These two varieties continue to flower for a long time, the latter varying greatly with the treatment it receives, and while the greatest numbers are usually sent away in January a few are often left for the Spring Flower Show in early March. Soleil d'Or is one of the most important kinds grown since, except for Paper White, it is ready before any others, either here or on the mainland, and cannot in fact be grown satisfactorily out-of-doors elsewhere in England. In the early days of the industry there were many other varieties similar to these two, but now Scilly White and Grand Primo are the only others produced in any quantity. These open in January and soon after them come the earliest of the daffodils or trumpet narcissus. Magnificence, The First, Golden Spur, Obvallaris, *Maximus superbus*, King Alfred, and Victoria, with Princeps, already mentioned, are the commonest of the trumpet varieties. Large-cupped narcissus such as Helios, Hospodar, and Fortune, and the small-cupped kinds such as Sunrise and Bath's Flame help to swell the supplies during the main season of February and March. At the end of the season some Actaea, Cheerfulness, *Ornatus maximus*, and finally Double White, are marketed and the narcissus season finishes in late April.

Most of the bulbs receive better treatment than the Princeps. They are usually planted in soil which has not grown bulbs for two or three years. They are usually lifted again in three or four years, but some bulbs have remained in the soil longer as a result of labour shortage. Planting takes place from early July until late October and often follows early potatoes. A single-furrow horse plough is used and the bulbs are placed 2-4 inches apart against the up-turned furrow. Six- to eight-inch furrows are ploughed and the bulbs left 3-4 inches deep. After six rows have been planted a furrow is left unplanted as a pathway or "vore" for the pickers between the six-row beds of bulbs. If time permits the surface is cultivated as planting goes on; four- or five-tined forks (known as "crooks"), with the tines bent at right angles and fitted to long handles, are used for this work. Weeds are numerous, and if seedlings appear before the bulbs the land is lightly harrowed, or "crooked over," to kill or check them. A few farmers are using some of the new hormone and other weed-killers to destroy the broad-leaved weeds, and if there is time weeds such as false oat-grass may be removed by hand. No cultivation is possible after the leaves emerge.

Growers try to pick the flowers just as the buds have burst or, with polyanthus types, when the first "pip" is open. During busy periods flowering tends to outpace picking and some may not be gathered at exactly the best time. Nearly all the picking is done by men, a thousand bunches being considered a good day's work. The stems are snapped off at ground level with the right hand and transferred to the left, the bundle being placed in the "vore" to be collected later and carried in baskets or boxes to the glass-

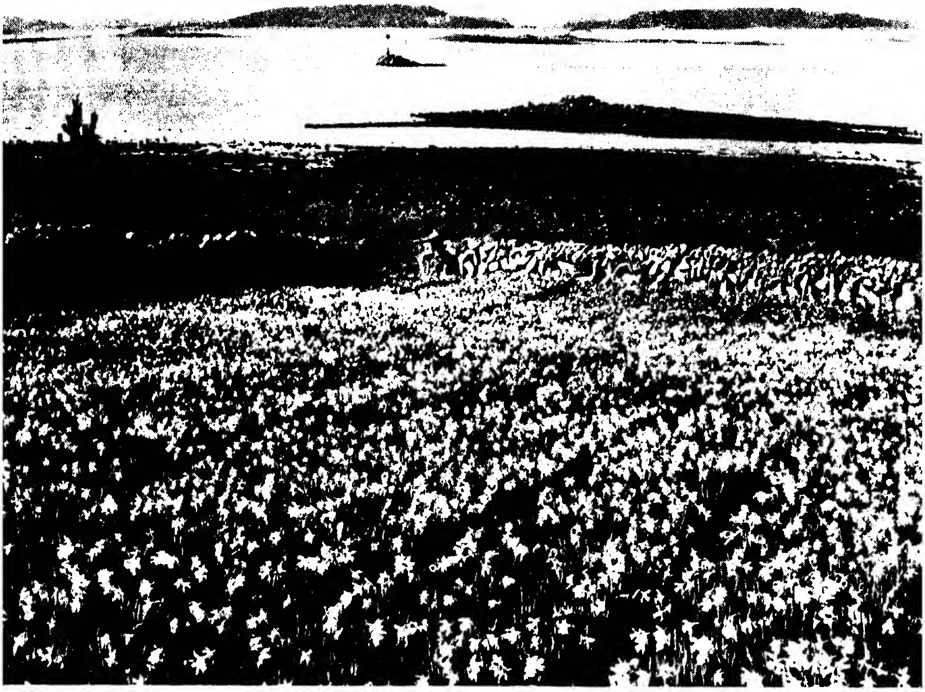
house. Each farm has one or more of these structures in which the newly-picked flowers are stored in water in glazed pots; the warm, light conditions are ideal for the opening of the flowers. When the flowers are open, women tie them in bunches of twelve with raffia or rubber rings. Modified bunching cradles are used on the largest farm, but on all the others the skilled tiers produce standardized bunches which fit well into the boxes. After bunching, the flowers are again stood in water in a "coolhouse" or shed; it is important that the flowers should be kept as cool as possible and well supplied with water before they begin their journey. The stems and flowers must not be wet, however, and the bunches are drained for a short while before packing. This is done in wooden, or sometimes cardboard, boxes holding from one to four dozen bunches, according to variety. Unfortunately present conditions make it necessary for returnable boxes to be used; these must be strong, and therefore heavy, to withstand the double journey, and are thus costly to transport.

From the four "off" islands they are conveyed in a cart or barrow to the small quay, and passed on to a launch for a half-hour journey to the steamer at St. Mary's. Loading often continues until midnight and begins again at six o'clock a.m. to be finished at eight or nine, when the steamer leaves for Penzance. Three trips are made each week, and at the peak of the season up to 40 tons of flowers are carried each time. Three hours is the minimum time for the passage, and it may be double that in bad weather. On arrival the boxes of flowers are taken by lorry to the station to be entrained for London, the Midlands, and the North. This frequent handling and long travel makes careful preparation and packing of the flowers particularly necessary.

After picking nothing can be done to prevent weed growth until the leaves are dying. The beds are then cut over, and if there is much grass it is made into hay. When other weeds are plentiful the rubbish may be removed for burning—often on to beds of Soleil d'Or. This burning produces earlier flowers the following season and is practised by many farmers on at least part of their beds. Some growers also cut the leaves of this variety while they are still green, lift the bulbs at once, and place them in their glasshouses to ripen. The bulbs can then be replanted earlier than usual to produce very early flowers. It is generally agreed, however, that this should not be done too frequently, since it reduces the bulbs in size and quantity. The bulbs are ploughed out with the single-furrow plough, each furrow being broken up with crooks in order to find all the bulbs. As they are lifted the bulbs are thrown together in lines 3 or 4 yards apart and running at right angles to the furrow; weeds and rubbish are thrown into similar lines which alternate with the bulbs. A few farmers place them straight into boxes but the majority allow them to become more or less dry before removing them to their sheds.

The intensive production of any crop often leads to a high incidence of parasitic pests. The narcissus crop in Scilly is certainly attacked by several organisms, but possibly no more than in similar intensive areas on the mainland.

Bulb eelworm is greatly feared and many stocks are regularly subjected to hot water treatment each time they are lifted in order to kill this pest. One or two farmers have their own equipment, which consists of a boiler and tank (or tanks) in which water is maintained at a temperature of 110° F. The majority, however, make use of the publicly-owned plants. This hot water treatment also kills the grubs of the narcissus flies, but these are not widespread pests. The Lesser fly in particular is rare, and the large narcissus fly occurs in appreciable numbers only from time to time; it is probable



A flower field on St. Mary's, with Tresco in the background.

Photos: *James Gibso*

Flower picking. Note the typical shelter fences.

The planting of bulbs takes plac
and the flowers are mark

July until the end of October,
November until late April.

A farmstead on Bryher.

Photos: *James Gibson*

Sheltered "squares" at Higher Town, St. Martin's.

that the frequent high winds tend to keep these pests in check. Bulb mite and bulb scale mite occur occasionally, but their attacks are seldom serious.

The conditions in the islands are particularly suitable for the development of leaf diseases, four of which are recognised as being important—Fire, Leaf Scorch, White Mould, and Smoulder. Some growers have recently been spraying with copper fungicides in order to control these diseases.

White Root Rot, caused by a *Rosellinia* fungus, and known locally by that name, occurs occasionally, often spreading from some of the shelter plants; the roots of *Pittosporum* are particularly susceptible to this disease. Small patches are dealt with by lifting the bulbs and destroying them and then digging in bleaching powder to kill the fungus. Another trouble which is causing considerable damage is known as Root Rot and is associated with the presence of a fungus and an eelworm, neither of which can be said with certainty to cause the disease. These and other minor troubles make it necessary to keep a continual watch on the bulb stocks and to adopt a cropping rotation where possible.

Vegetables and Other Flowers

On many holdings vegetables and other flowers of minor importance are to be found in small quantities. Ixias are grown in beds in much the same way as narcissus and are sent to market during May. *Gladiolus byzantinus*, a small reddish-purple flower, is sent about the same time. This is not grown as a crop but appears in some quantity in many of the bulb fields. Named varieties of gladiolus and iris too are grown in small quantities, usually from imported corms which survive only for a few years. An exception is Gladiolus var. Ne Plus Ultra, which has been grown in small quantities for some years. A few years ago arum lilies were produced out-of-doors on two or three farms for the spring markets, but they are not now very plentiful.

Anemones, which are so widely grown in Cornwall, are not very successful on these islands and are rarely grown ; they need heavier soils than those found in Scilly. Stocks and wallflowers are sown in late spring, the former for late autumn and winter sale, and the latter for cutting in very early spring. Calendulas and myosotis are sown in late summer for sale during the winter, and both may produce good returns when frost or snow has reduced the supply of flowers from other areas. Violets are grown by a few of the smaller growers but they are not liked ; they are looked upon as being too small and troublesome, compared with the larger crops.

The earliest potatoes in the British Isles are produced in the Isles of Scilly ; in a year without frost, lifting begins about the end of April and continues for about six weeks. Dargill Early was until recently the favourite variety, but the stocks of this variety are now so mixed that they cannot be relied upon, and other, less suitable, kinds are being tried. Arran Pilot, Ulster Chieftain and Home Guard are all, for one reason or another, not what is wanted, and the search for a short-stemmed, wind-resistant, early-maturing kidney variety goes on. The land is prepared by ploughing-in a thick layer of fresh seaweed a month or more before planting, or by turning in pile dung, either before or when planting is taking place. A complete fertilizer is usually applied at planting time, and more may be added when the plants are a few inches high. Seed is planted from December onwards, the aim being to get it out of the way before the busy flower season. It is ploughed in, planting every other (or sometimes every) 9 to 10 inch furrow, upwards of 2 tons of seed being used to the acre. On very small plots the soil is turned over with the long-handled Cornish shovel and the potatoes planted in the

same way as when a plough is used; the crop is also lifted with these shovels. In days gone by all the fields were dealt with similarly. The land is usually hand- or horse-cultivated after the plants are through but no earthing up is done.

A single frost may cut the plants to ground level, and such frosts do occur during January and February and even early March; many potatoes are growing well by February, so the risk of a check to growth is considerable. The plants usually recover, however, and the bulk of the crop is generally lifted during the four weeks beginning the middle of May. Potato Blight occurs much earlier, of course, than on the mainland; it has been seen in April and is often widespread by mid-June. As a result, maincrop potatoes are not easy to grow properly, for spraying is not economical where tractor- or horse-drawn machines are too large to be used.

A few broccoli, early spring cabbage, onions, and outdoor tomatoes are grown for sale on the mainland, but most other vegetables for local use are brought from there. The two brassicas pay well only if severe weather reduces supplies elsewhere, and in most seasons the heavy freight charges make it difficult to compete with mainland growers. Onions can be produced successfully, but weeds are a serious problem and ripening is not always easy. Tomatoes need to be grown in the more sheltered spots and Potato Blight must be guarded against by repeated spraying.

Weeds Reference has already been made to the prevalence of unwanted plants in the crops. With a climate that provides ideal growing conditions almost uninterruptedly throughout the year, it is inevitable that weeds should grow strongly and continuously. Not only are the common English weeds, such as couch, creeping bent, wild oats, corn marigold (bothem locally), sheep sorrel and spurrey present in quantity, but there are exotic weeds which are even more troublesome. *Allium triquetrum*, a white-flowered onion producing large numbers of seeds and dividing its bulbs readily, has a similar growing season to the cultivated bulbs, thus making it very difficult to kill. This plant is thought to be a native of West Cornwall, but not of the Scillies, where it is now established in the bulb fields and hedges and roadsides—on St. Mary's in particular. Various species of oxalis are also troublesome weeds, since they produce numerous deep, corm-like roots which are difficult to kill. Another recently introduced plant causing trouble is *Claytonia perfoliata*, known locally as waterweed. This native of North America chokes the bulb leaves and produces seeds before they can be cut down and the plant destroyed. Spotted medick is another troublesome plant which seeds readily before it can be killed, while the annual nettle is just as prevalent in the islands as on market gardens on the mainland.

The ubiquitous thistles and docks occur here as elsewhere and the fiddle dock (*Rumex pulcher*) is widespread in pastures in the islands. The narcissus bulbs themselves can be looked upon as weeds, for they are very persistent when left behind at lifting time, and care has to be taken to remove them before the time for planting the next bulb crop comes round. Potatoes, too, continue to grow at all times and are a source of infection from which Blight spreads to the cultivated plants.

Livestock The islands are self-supporting in milk, but it is not possible to send any to the mainland; nor could supplies coming by steamer be relied upon. Milking is done in the fields on some farms in the summer, and many animals are out-of-doors all the time, except for milking

They all spend their days in the fields throughout the year. The cattle are almost exclusively Guernsey or Guernsey type, pedigree bulls of that breed having been used for about twenty-five years on St. Mary's and for nearly as long on Tresco ; St. Agnes and St. Martin's usually obtain young bulls from one or other of these islands and, while they are not pedigree animals, they are of good Guernsey type. Farmers on the remaining island of Bryher rely on the neighbouring Tresco, which can be reached through a few inches of water during an hour or so in the middle of a few days each month when spring tides provide low water. There is very little traffic of animals in either direction between the islands and the mainland, and as a result of this isolation the animals here are remarkably free from disease. Contagious abortion has not occurred for many years, mastitis is rare, and as a result of tests carried out in the past eighteen months, over 90 per cent of the herds are now attested and the remaining few are awaiting further tests before getting their certificates.

In the last year or two efforts have been made to improve the cattle still further, with a view to building up a stock from which heifers and young bulls can be sold on the mainland. A Milk Recording Society was formed at the beginning of 1948, and with its aid it is hoped that some herds may grade up to pedigree standard, that many more will produce young stock with good records behind them, and that the progeny of the bulls in use will provide information as to their value. It is realized that cattle are essential both to supply milk and to make use of the grass which can form an integral part of the farm rotations. Since the Guernsey is well suited to the mild but windy climate and to the lime-deficient soil, there is every encouragement to improve and provide much needed replacement stock for less-favoured areas.

Other animals are of much less importance than the cattle. It is extremely difficult to produce corn to help feed pigs or poultry, and if it were grown it could not be threshed. No sheep have been kept for some years ; the breeds which would suit the rough, open country would be difficult to keep out of the important arable fields, and the small farms could not find much keep for other kinds.

Horses are still the main source of power for hauling seaweed and for the land work, but all these are brought from the mainland and no stallion is kept. Within the past two years several farmers have bought light four-wheeled tractors with tools attached, and others have very small caterpillars or two-wheeled machines.

Many farms must, of necessity, now be self-supporting in feeding their cattle, since they are not selling enough of their milk to enable them to draw rations for concentrates. Mangolds, swedes, kale, drumhead cabbage and maize are grown, and they enable the land to be cleared of weeds and stray bulbs before another bulb crop is planted. Mangolds are sown before early potatoes are lifted, often on land which carried the previous season's maincrop potatoes ; the other fodder crops follow early potatoes or bulbs.

The late flowers, early potatoes and root sowing and hoeing occupy the farmer in the spring and early summer ; consequently haymaking tends to be late and the resulting hay correspondingly poor. Since, however, the growing season is long, late-sown roots and the grass provide food of fair quality during many months of the winter and the need for high quality hay is not quite so great. Generally speaking, the grassland is poor ; ryegrass, sweet vernal and bents produce some growth in the spring, but in

many seasons the pastures are bare and brown for long periods in the summer, the only grazing coming from wild white clover, which grows abundantly. Some leys are now being sown with pasture-type cocksfoot, timothy, meadow fescue and S.100 white clover, and it appears that the grazing season can be extended considerably.

An Industry based on Bulbs and Early Potatoes

As in most areas there are advantages and disadvantages under which the farming is carried on. Weeds, high winds and heavy transport charges are among the difficulties that have to be faced. But the climate and soil make it possible for the industry to be something more than subsistence farming—which it would be if bulbs could not be grown.

The bulbs must have priority in all cultivations and, of course, occupy a large proportion of labour on the holdings for much of the year. The busy harvest season is from January to April, and early and maincrop potatoes have to be planted at the same time. Root sowing and hoeing and potato lifting follows during May and early June, when haymaking and bulb lifting must be attended to; both continue through the summer, and replanting is also carried on until late autumn. Maincrop potatoes for local use are lifted rather early if possible, and seaweed hauling occupies the remaining months until Christmas and other times when the seas are sufficiently rough to bring in the weed from the outer rocks and sea bottom.

Early potatoes provide a useful alternative to bulbs, rest the land and give the farmer a chance to eradicate rogue bulbs and weeds. In war and peace they have paid their way and enabled the Islands to contribute to the food supplies of the nation, but falling prices, with increasing competition from the Continent, make it likely that the crop will be less widely grown in future. The future is in fact not so assured as for mainland farmers, for the only really satisfactory crops which can be grown are not provided with guaranteed markets or prices. Flowers must remain the backbone of the industry and, as with all horticultural produce, prices fluctuate with supply and demand and the quality of the produce on arrival at market. It is for this reason that great efforts are being made to improve the quality of the bulbs and the livestock, so that there may be a useful addition to the farm sales.

INCREASED STOCK PRODUCTION

JOHN DAVIES, B.Sc.
County Agricultural Officer, Breconshire

DURING the war increased production from farms was generally measured in terms of increased tillage acreage. It is doubtful, however, whether an increase in the tillage acreage alone gave a true indication of increased production from the land, particularly in Wales. Because of its high rainfall this area is better suited to stock rearing and the production of seed potatoes than grain.

From 1939 to 1944 tillage increased in Breconshire, as in other counties, but since that time there has been a gradual decline. Had full use been made of the tillage acreage, there should have been a corresponding increase in the numbers of cattle and sheep.

The tillage acreages for two-year periods between 1939 and 1947 and for 1948, and the numbers of cattle and sheep on the June returns, are as follows :

Year	Tillage *acres*	Cattle	Sheep
1939	16,729	40,391	555,400
1941	39,747	42,222	474,923
1943	49,539	44,793	539,700
1945	46,407	45,541	565,118
1947	38,545	43,363	358,776
1948	38,530	46,035	452,603

These figures show that the numbers of stock follow fairly closely the rise and fall in the tillage area, except for sheep in 1941, when the natural tendency was to reduce stock in response to directions for more tillage. As new leys were put down, the numbers of sheep increased. The reduction in the numbers of sheep and cattle in 1947 is largely due to the disastrous winter of 1946-47. During this period the abnormal severity of the weather accounted for a loss of 1,000 cattle and 144,000 sheep in Breconshire.

It can be seriously questioned, however, whether the war-time increase is a sufficiently high aim in the present expansion programme. Very large areas of hill and marginal land were ploughed up and reclaimed during the war years ; this acreage has now been seeded back to grass and the pastures formed are in a condition to carry more stock than the old pastures. Unless these areas are fully stocked and properly managed they will soon deteriorate.

During the later years of the war the Breconshire A.E.C. bought through the Ministry of Food Collecting Centres up to 2,000 calves annually and reared them on lands in possession. Later these animals were sold, mostly as stores, but some as finished beef cattle, and made a substantial contribution to the country's meat supply. The salvaging of calves from the Collecting Centres was also carried out and expanded by a number of farmers in the county. Some were not satisfied with selling beef stores ; they realized that there was also a good demand for good quality dairy heifers, and as a result they adopted the following method of rearing.

Fairly useful dairy cows are served by a good Hereford bull. The colour-marked calves are reared on their mothers for two to three months and become good store cattle. When weaned they are replaced by purchased dairy heifer calves, and during the summer months each cow rears at least one dairy heifer calf in addition to her own Hereford-cross calf. A number of farmers rear attested cattle and invariably find that there is a good demand for the dairy heifers when sold later either as bulling heifers or down calvers.

If this method of rearing were generally adopted on upland farms and farms so situated that milk selling is not at present practicable, livestock production could be increased considerably, since most farmers today seldom rear more than one calf per cow. With a very small additional outlay on calves and labour, the income can also be increased substantially. The Calf Rearing Subsidy Scheme is an additional inducement to contrive ways and means of improving housing accommodation and increasing the supply of winter fodder and feedingstuffs.

The improvement and reclamation of permanent pastures and rough grazings are the means to this end. Improvement calls for an increase in

the numbers of sheep to consume the pioneer crops on reclaimed areas and for an increase in the number of cattle when the new pastures are established.

With the grants to be obtained under the Hill Farming Act, Hill Sheep and Hill Cattle Subsidies, and the Calf Subsidy Schemes, there is every inducement for a far greater expansion than is anticipated under the present expansion programme.

A STUDY OF PRODUCTION POLICY IN DAIRY HERD MANAGEMENT

KENNETH N. RUSSELL, B.SC., N.D.A.
Vice-Principal, Royal Agricultural College, Cirencester

IN the interpretation of the financial results from dairying, or for that matter from any farm enterprise, it is essential that the conditions under which those results have been obtained should be taken into account. Dairying is conducted on farms which differ not only in size and general level of fertility, but also in such important respects as watering facilities, cottage accommodation, and buildings for stock. What is easy to accomplish on one farm may be impossible on another, and the test of a farmer's managerial skill is how he can best adapt methods to circumstances. This article describes how the two kinds of dairy farms run by the Royal Agricultural College have been organized and how they compare economically.

Planning the Dairy Unit: THE SMALL FARM

One of the farms (Steadings) covers 57 acres and is equipped with orthodox cowshed and loose boxes; it is typical of that very large class of British farms which are less than 80 acres in size —the family farm. In such cases farming must be intensive, and a high production income per acre is all-important. The dairy herd is the main source of income, and a high milk production per cow, combined with a high level of stocking, is essential; intensive crop production is therefore necessary. The income from milk on The Steadings farm is raised by concentrating production in the winter period (November-February) when milk prices are highest, and by the production of T.T. milk. Preparations for attestation began in the autumn of 1945, and the herd was attested by the spring of 1947.

The herd was established with a total number of 16 cows at a cost of approximately £1,100, which in 1945 represented a reasonable figure for T.T. British Friesians. It may therefore be taken as a fair cross-section of that type of dairy cattle. It has grown to the present 21 cows and heifers in milk or dry; six home-reared heifers have been introduced and at the end of the past milk recording year there were 21 young stock, all home-reared. The cows are hand-milked, the highest yielders three times daily, particularly in early lactation; feeding of concentrates and maintenance foods is strictly controlled: this is not difficult with cows tied up in sheds for milking and feeding in winter and given access to small well-watered fields for restricted or controlled grazing in summer.

The Large Farm In direct contrast to The Steadings, where the dairy herd completely governs the farming system, the College is able to demonstrate on the adjoining Fosse Hill and Field Barn farms how a dairy herd can be fitted into a much more varied system of farming. Here the dairy herd ranks second to cash crops in the farm economy, but cash cropping and dairying are complementary, not competitive. The thin Cotswold brash soil on which these farms lie requires liberal supplies of dung or turf ploughed in to produce good arable cash crops, so that in planning the organization of the dairy herd the need for a stable, well-balanced stocking policy was kept well in mind. On these farms, however, no dairy buildings existed, and the following methods of running the dairy herd were considered:

1. Building a new cowshed along orthodox lines;
2. Using an outdoor bail and either (i) completely outwintering the cows or (ii) housing them in yards during the winter, using the portable bail as a fixed milking parlour on a concrete base for the winter period only; or
3. Converting existing buildings into a permanent milking parlour and housing the cows in yards during the winter.

Of these three possibilities, the first was ruled out because of cost—in any case, as tenant of the farm the College was not the sole arbiter. The second was abandoned because (a) Cotswold land, though liable to summer drought, is by no means as free-draining under wet conditions as the chalk downs, and winter poaching of the land under bail milking is likely to be severe, particularly on new leys, and (b) working conditions for the dairy staff were likely to be rather trying. It was finally decided to adopt the third method, which, incidentally, enabled a range of existing loose boxes to be utilized. The necessary winter accommodation for the dairy cows was obtained by converting Dutch barns into covered cattle courts fitted with feeding troughs and racks.

A second feature of these farms was the shortage of cottages suitably situated for dairy workers. Whatever system of dairying was employed a high output per man was essential, so that in the change-over from cattle-fattening and sheep-folding to dairying the following factors were given greatest weight:

1. The need to economize in capital expenditure on buildings or other structural alterations (tenant's fixtures) so that as much capital as possible could be invested in livestock to build up fertility;
2. The importance of adopting labour-saving methods, e.g., using milking machines and accommodating the cows in yards to facilitate handling of bulky foods and dung.

This herd was established in the autumn of 1945 by the purchase of 40 Ayrshire bulling heifers (attested and non-pedigree) for £1,680. During 1945-46 the necessary building alterations were undertaken, milking plant installed, and the Dutch barns modified to accommodate the milking portion of the herd during the winter. Each of the four yards has room for eight cows, allowing a floor space of 80 square feet per cow. The animals are grouped in the yards in order of calving; they receive their concentrates whilst being milked in the parlour, and bulky foods, such as hay and silage, in the yards. All those in the milking herd were dehorned in March, 1947, the inadvisability of yarding horned cows having been amply demonstrated in the six previous months when a lighter stocking of each yard (120 square feet per cow) had been practised. No serious effects resulted from de-horning; after an immediate drop of less than 10 per cent, the milk yield soon rose to above the previous level from the same number of cows in milk. All calves are now dehorned as a matter of routine.

Economic Results The results for each herd are presented below, attention being drawn first to the net output in gallons of milk per man and per cow and then to the costings figures for each herd.

Table 1

Steadings Farm (57 acres)

Year (Oct. 1–Sept. 30)	1945–46	1946–47	1947–48
Average number of cows in herd	16	16	19
Total output (*gal.*) (Sold to M.M.B.)	15,061	15,314	19,293
Output per cow (*gal.*) (Sold to M.M.B.)	941	957	1,015
		AVERAGE = **971**	
Output per man (*gal.*)	7,530	7,657	7,717
		AVERAGE = **7,635**	

The milk production figures for this herd for the complete year 1946–47, as determined by the University of Bristol Economics Department, are compared in Table 2 with the average for thirty-five other T.T. herds costed in the same survey.

Table 2

Herd	Output per cow	Cost per gal. Net Total	Cost per gal. of Foods	Cost per gal. of Labour
	gal.	*d.*	*d.*	*d.*
Steadings	957	16.2	9.9	5.1
AVERAGE	606	18.5	10.4	5.5

These figures do, it is claimed, support the contention that high production per cow is a most important factor in lowering milk production costs.

Table 3

Fosse Hill and Field Barn Farms (365 acres)

Year (Oct. 1–Sept. 30)	1945–46	1946–47	1947–48
Average number of cows in milk	None	31	35
Total output (*gal.*) (Sold to M.M.B.)		20,150	25,200
Output per cow (*gal.*) (Sold to M.M.B.)		650	720
		AVERAGE = **685**	
Output per man (*gal.*)		13,430	16,800
		AVERAGE = **15,115**	

In interpreting these figures it should be borne in mind that they represent in 1946–47 the production from a herd composed entirely of first-calf heifers.

The detailed costings figures for this herd for 1946–47 compare as follows with the Steadings herd and the average herd in the sample of farms covered in the survey:

Table 4

Herd	Output per cow	Cost per gal.	Cost per gal. of Foods	Cost per gal. of Labour
	gal.	*d.*	*d.*	*d.*
Fosse Hill and Field Barn	650	21.4	11.9	5.1
Steadings	957	16.2	9.9	5.1
AVERAGE	606	18.5	10.4	5.5

This comparison serves to show that despite the much higher output per man in the Fosse Hill and Field Barn herd, increased labour efficiency was not sufficient to effect any saving in labour cost per gallon, owing chiefly to the lower yield per cow. The lower efficiency of the low-yielding cow is reflected in the higher cost of food per gallon of milk, as the maintenance cost of keeping a cow in food is a constant overhead cost, irrespective of milk output.

In reviewing results it needs to be remembered that the herds themselves are not strictly comparable. In the first place, the Steadings herd contained a high proportion of older cows, whilst the Fosse Hill and Field Barn herd consisted solely of heifers; secondly, the breeds were different. Circumstances also were different: on the one hand, limited land facilities dictated a policy aimed at high production per cow; on the other, lack of buildings

and cottages called for high labour output with the minimum of capital expenditure on buildings.

The average output per cow (971 gallons) attained in the small herd and the average output per man (15,115 gallons) in the larger one emphasize how inadequate any single measure of efficiency (such as labour output) is as a guide to the cost of milk production, if applied to herds kept under very different systems.

WARBLE FLY CAN BE REDUCED

W. G. MAITLAND

Hide and Allied Trades Improvement Society

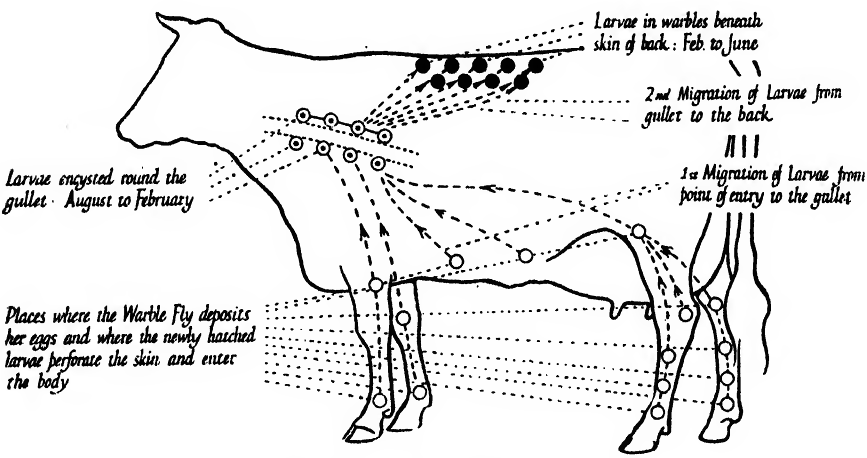
THE sight of a number of cattle suddenly, and for no apparent reason, careering wildly around a field with their tails in the air will be familiar to most stock-owners under the term of "gadding". In some cases they may think, "I should have got rid of the warbles by dressing those cattle", in other (and fewer) instances they may wonder why their animals should be attacked by warble fly when the regulation treatment has been applied thoroughly and carefully In the latter case they would most probably lay the blame at the door of a neighbouring farmer who had omitted to take this precaution, with the result that cattle which have been de-warbled are again being attacked by flies coming "over the hedge". But since, as is generally understood, the greatest distance that the warble fly will travel to deposit its eggs is not more than about 400 yards, one's neighbours cannot always justly be blamed when dressed cattle become reinfested

Derris Dressing from March to June This article is not intended to be a scientific treatise on the habits of the grub, some of which even now are not fully known, but it is hoped that it will serve as a reminder of the need to dress cattle with derris between March and June, and that some of the points made will show why action is necessary in the interests of the farmer as well as the ancillary trades dealing with hides and skins It is generally agreed in veterinary circles throughout all countries where the warble fly is prevalent that eggs are deposited on the cattle in spring or early summer and that, after a few days, the larvae emerge and burrow through the skin, thereafter gradually working through the muscular tissues of the animal until they reach the back—a journey taking several months. In the spring of the following year they start to bore breathing holes through the hide on the back, and eventually the now mature larvae emerge and fall to the ground. About six weeks later they change into flies, and the females begin their egg-laying "sorties" which cause such irritation and annoyance to the animals and makes them "gad" In this country the eggs are usually deposited on the legs, particularly the hind legs

Many tests and experiments have been carried out to ascertain the best means of exterminating the warble fly. The obvious lines would be to prevent the female from depositing its eggs, but so far this has proved impossible. Warble fly grubs erupt from the backs at any time during a period of three months or more, and thus the egg-laying flies can be on the "attack" for *at least* thirteen weeks. No substance for effectively repelling

the female warble fly when it approaches an animal to deposit its eggs has yet been found, nor is it likely that such a product (even if discovered) would be expected to remain active or potent for so long a period under everyday field and farm conditions. Therefore the only sure stage at which the pest can be tackled is whilst in its breathing hole in the animal's back.

The farmer has a duty to his animals to prevent them becoming infested. It can well be imagined that the discomfort caused by 5 or 10 (in some cases even 30-50) grubs boring through the hide over a period of perhaps three months is considerable. Abundant testimony is available in veterinary circles of the injurious and painful effects of the swellings on the back, and not infrequently large and painful abscesses are formed. The tissues on the back of slaughtered warbled animals often contain a jelly-like material which is known in butchers' circles as "licked beef" and has to be trimmed off before sale. Gadding often results in loss of condition and reduced milk yields.



Life-cycle of the warble maggot.

More than 50 per cent of the hides of cattle slaughtered during April to June each year contain open warble holes, with lower percentages during other months. Hides of animals which have been warbled but which are killed outside the grub-emerging season are scarred where the holes have healed. Open holes and scars are defects which lower the value of the hide and reduce the uses to which it can be put. Both constitute a loss to the nation, because perfect (unblemished) leather is an excellent export line to hard currency areas. There is, too, a good deal of actual waste when leather has to be cut to avoid the warble holes. We understand that one of the points helping to sell British cars abroad is the leather upholstery; yet a single warble hole in a hide will debar its use for such purpose. A tanner was asked recently to supply a special selection of unblemished leather for a large export order, but found that only 15 per cent of his English hides were suitable; the remainder were damaged, mostly by warble holes or scars. Argentine hides are not damaged by warbles, but in these days they are not easy to obtain because of currency and other difficulties.

Warble fly can be eradicated if infested animals are efficiently dressed with derris as required by the Warble Fly (Dressing of Cattle) Order, 1948

at least once every thirty-two days between March 15 and June 30. A "screwing" movement with a swab into each hole, *making certain that the dressing penetrates*, is advised, and it is important first to brush the surface of the hole to clear away dried pus, which otherwise will tend to prevent the liquid derris from reaching the grub. Alternatively the solution can be well brushed all over the back of the animal. The dressing required by the Order should be made up (per gallon) of:

(a) either 1½ oz. derris resins or ½ oz. rotenone; and also
(b) 4 oz. soap, which may be added at the time of dilution or may be incorporated in the preparation in powder form

prepared *immediately before use* by diluting with water.

The cost of derris treatment is very low, but the effort can be wasted unless the liquid gets into the breathing hole.

Every stock-owner should have his animals examined for signs of warble infestation between March 15 and June 30. If warbles are visible he should at once apply the recommended derris dressing; and if this is done properly almost 100 per cent destruction of the grubs can be secured.

EARLY PLANTING OF MAINCROP POTATOES: SPROWSTON EXPERIENCE

P. N. HARVEY, M.A.
Norfolk Agricultural Station, Sprowston

IN the January, 1949, issue of *Agriculture*, J. D. Ivins and N. McDermott described a trial carried out at the Nottingham University School of Agriculture in 1948 to investigate the effect of time of planting on the yield of the potato crop. During this same season, experimental work on similar lines was being conducted at the Norfolk Agricultural Station: the planting times were, however, earlier than those selected for the Nottingham experiment, and for this reason the findings of the two trials are in a sense complementary and, taken together, strongly support the arguments advanced.

The trial at Sprowston was laid down on a light loam soil overlying brick earth, and cultivations and manuring followed the usual practice on this farm. The lay-out of the trial was complex and included a comparison of two varieties (Arran Banner and Majestic) and three planting distances in the row, in combination with three planting dates at twenty-four day intervals. Unsprouted seed of Majestic certified H (Scot.) and Arran Banner certified A (N. Ireland) was graded between 2-inch and 1¼-inch riddles and boxed ten days before the first planting. The trial crops were lifted by elevator digger on October 22 and the results are summarized in the following table.

Table 1

Date of Planting	Variety	Ware (over 2 in.) *tons per acre*	Seed (2 × 1¼ in.) *tons per acre*	Total Yield (ware, seed, and chats) *tons per acre*
March 19	Arran Banner	12.8	3.3	16.1
	Majestic	14.9	2.8	17.7
April 13	Arran Banner	14.5	3.2	17.7
	Majestic	14.0	3.2	17.3
May 7	Arran Banner	13.1	2.7	15.9
	Majestic	11.6	3.1	14.8

In the case of Majestic, the loss in yield when planting was delayed from April 13 until May 7 was 2.4 tons of ware per acre; this compares with 3.69 tons per acre in the Nottingham trial, where Majestic was also used and where the interval between plantings was approximately the same length but about a fortnight later. The results show that in 1948, although doubtless the most serious losses occurred when planting was delayed until after the end of April, any delay after the middle of this month caused an appreciable reduction in yield.

The variety Arran Banner, however, behaved differently: here the third planting yielded only 1.4 tons of ware per acre less than the second (about half the corresponding difference recorded for Majestic), while the first planting, which gave the best crop of Majestic, yielded worst of all. This suggests that Arran Banner did not suffer from late planting to the same extent as Majestic. Clearly varietal characters have an important bearing on the best time of planting; otherwise, to take an extreme case, there would be no distinction between early and maincrop types.

The effect of varying the planting distance in the row is shown in Table 2, the yields being averaged for the two varieties and the three times of planting.

Table 2

Planting Distance in Row	Ware (over 2 in.)	Seed (2 × 1¼ in.)	Yield (ware, seed, and chats)
inches	*tons per acre*	*tons per acre*	*tons per acre*
12	12.6	3.8	16.4
16	13.6	3.1	16.7
20	14.3	2.3	16.7

As the planting distance was widened there was a marked increase in the yield of ware and a corresponding reduction in the yield of seed. Results obtained in experiments carried out by the Norfolk County Council in West Norfolk* were similar, except that in the present trial the total yield was not reduced when the planting distance was increased.

*Findlay and Sykes. *Emp. J. of Exp. Agric.* (1938) 6, 253.

FARMING AFFAIRS

Silage by the A.I.V. Method On pp. 513-517 of this issue, Dr. H. E. Woodman discusses the subject of silage with particular reference to the A.I.V. process. The following note is extracted from a lecture, "Silage by the A.I.V. Method," delivered by Professor A. I. Virtanen before the Royal Dublin Society and published in the Society's Economic Proceedings, June, 1947.

In 1933 I bought a farm in order to apply in practice my ideas of the biological fixation of nitrogen, of the production of protein, and of the feeding of cattle. The principle adhered to in the farm management was that nitrogen is bought in no form, neither as fertilizers nor as concentrates. According to my calculation it should be possible to obtain sufficient nitrogen from the atmosphere by means of the legume bacteria, and simultaneously also sufficient protein on a farm, where the production of milk and meat is the chief concern. This line of production is general in Finland under normal conditions.

The cultivated area of my farm is 38 ha. (95 acres). This has been utilized as follows :

		ha.
Pastures of long duration	about	8 –11
Three-year clover-timothy fields .. .	,,	12 –15
Spring wheat (nurse crop of clover-timothy field) ..	,,	4 – 5
Oats (partly mixed with vetch or pea) . .	,,	4 – 6
Potatoes	,,	2 – 5
Pea and annual green mixture	,,	1 – 2
Marrowstem kale	,,	½ – 1

Dung and urine are collected separately. Of purchased fertilizers only superphosphate is used, and its annual amount is approximately 200 kg. per ha. (approx. 1⅝ cwt. per acre). When clover-timothy fields are established with spring wheat as nurse crop, they are given a fertilization of 30-35 thousand kg. of farmyard manure (12-14 tons per acre) and of 600 kg. superphosphate per ha. (approx. 5 cwt. per acre). Soils which are very acid in nature were limed in 1933 and 1934 with an average of 5,000 kg. ground limestone per ha. (2 tons per acre). Potatoes are given about 7,500 kg. (3 tons per acre) urine and 250 kg. (2 cwt. per acre) superphosphate per ha. ; marrowstem kale also receives a heavy urine fertilization.

Clover seed is always infected with cultures of efficient legume bacteria, as well as the seeds of vetch and pea.

Clover-timothy fields of first and second year are cut three times per summer, and the crops are made into A.I.V. silage, unless it is necessary to graze the second and partly also the third crop in dry summers. When the weather conditions of the summer are favourable the yields of the fields amount to 40,000 kg. fresh fodder per ha. (16 tons per acre). Under unfavourable weather conditions they remain 20,000 kg. (8 tons per acre). One half of the total amount of the A.I.V. silage on the farm is usually made from the first cut of the fields.

The crop of the third year fields is dried into hay on stakes. The major part of the potato tops are also made into A.I.V. silage. The yield of potato tops is usually about 8,000 kg. per ha. (3.2 tons per acre).

The livestock of the farm comprises at the present 23 dairy cows, 1 bull, 7 calves and heifers, 5 horses, some pigs and hens. The annual milk production per cow has been on the average nearly 4,000 kg. (880 gallons) calculated as 4 per cent milk.

During the past 14 years I have thus proved in practice that a high milk production can be achieved even so far up in the north as Finland without protein-rich concentrates, and that sufficient protein for such a production can be produced by means of biological nitrogen fixation

without nitrogen fertilizers. Although, of course, it is profitable to the farmer to give, when needed, nitrogen fertilization to such plants as benefit from it, it is important to know what can be attained without expensive nitrogen fertilizers.

Hill Farming Improvement Owners and occupiers of hill farms who are willing to carry out schemes for the improvement of their land are eligible for financial assistance under the Hill Farming Act, 1946. Grants amount to one-half of the cost of the work done under approved schemes, which must be sufficiently comprehensive to ensure the proper rehabilitation of the land for hill farming purposes. These grants may cover a wide range of improvements, such as (i) the repair and modernization of farmhouses, (ii) the construction or improvement of cottages, farm buildings, roads, and bridges, (iii) the provision of water and electricity supplies, (iv) the improvement of grazings, drainage and fencing, and (v) the planting of shelter belts. By the end of 1948, no less than 1,951 proposals for improvement schemes had been put forward in England and Wales. When there is urgent work to be put in hand, no one need be held up. Authority to get on with the work can be given by the County Agricultural Executive Committee or the Land Commissioner, on the understanding that grant will be paid if the work is done satisfactorily and included later in an approved scheme. In some counties one-quarter to one-half of the schemes are being dealt with in this way.

As much as possible is being done to avoid unnecessary formality in the preparation of documents. Schemes can now be finally approved on a general description of the work with a rough estimate of the cost; detailed specifications, plans and estimates can be submitted to the County Committees later on, when the promoters are ready to start the work. Expert help and advice are available from the Committees and the Agricultural Land Service of which, it is hoped, all concerned will take advantage. It is in the promoter's interest to submit his scheme as quickly as possible, for once a scheme has been approved, grant can be paid for any completed work.

Hill Sheep Subsidy: England and Wales The standard rate of subsidy payable in 1949 in respect of self-maintained flocks of eligible ewes and shearling ewes of hardy hill breeds kept on hill farms in England and Wales on December 4, 1948, has been fixed at 10s. per head. A "reduced rate" of subsidy at 5s. per head will also be payable in respect of flocks of eligible ewes maintained by the purchase of ewes, shearlings or ewe lambs, including flocks where all or part of the flock is put to a Border Leicester (including the blue-faced type of Leicester), Wensleydale, Kerry Hill, Clun Forest or Devon Closewool ram for the production of cross-bred lambs for sale. Ewes of the following breeds or crosses between any of the breeds are eligible: Cheviot, Derbyshire Gritstone, Exmoor Horn, Herdwick, Lonk, Radnor, Rough Fell, Scottish Blackface, Shetland, Swaledale, Welsh Mountain, and certain local breeds.

The subsidy will normally be payable to the person owning or renting the flock on December 4 last, and will cover all eligible ewes (including shearlings but excluding ewe lambs or hoggs) in the flock on that date. Where, however, there were losses of ewes due to the bad weather early in 1947, payment may be based on the number of eligible sheep on the holding

at December 4, 1946, if this is considered to be fairer and the applicant so elects. No advance payments will be made this year in respect of next year's subsidy.

Application forms are being sent by County Agricultural Executive Committees to all farmers whose applications were accepted last year and to incoming tenants on farms or land eligible for subsidy. Completed forms should be sent to the Committees without delay *and in any case in time to reach them not later than April* 30, 1949. Failure to do this may result in disqualification. Any person entitled to apply who has not received an application form is advised to write at once to his Committee.

Nature Month by Month—March In this month spring "officially" begins, and indeed there are many signs that at least it is on the way. Of all spring portents there are two for which I look most eagerly. There is a small, tubby, black bee, burdened, I think, with the name of *Anthophora pilipes*, shy and hard to come at, fast as a flash on the wing. On a sunny day one may see it on or near the flowering currant and, if one keeps very still, even detect the yellow pollen sac on each hind leg.

For my second portent I look in the birch wood, round about Lady Day. If the weather is sunny, there will be the beautiful little orange-underwing moths, flying in numbers about the bare birch twigs. When the sun goes in, the moths go, too.

In the still leafless garden hedge there is a dunnock's nest with its first egg of pure bright greenish-blue, like a fragment of fallen evening sky. The tall elms by the rectory are clamorous with rooks, busy with domestic matters. There is much carrying of sticks and squabbling about rights; now and then a real battle still further excites the rookery.

On the leas the lambs gambol and frisk, full of the joy of living, doing absurd things with their tails as lambs always do at this season. One little fellow has a trick of springing high in the air from all four feet at once, like a bucking mustang.

All the world seems full of young things now. By the shippon there stands a day-old Devon calf, balanced precariously on awkward, stilt-like legs, plainly wondering what it is all about and, it seems, by no means certain yet that life is worth living. Already the wild rabbits have nurseries in occupation. By the hedge I came upon a strayed youngster hardly bigger than a child's fist. I held him in my cupped hands for a while and then (no doubt quite foolishly) let him go. He departed with what speed he could, his tiny legs working in a frenzy of effort to escape.

In the wood the snowdrops are over, but soon there will be anemones. In field and garden new green things are pushing up through the soil. Birds and beasts are growing busier with each passing day, and in a short while the great work of creation will be in full swing everywhere.

F. H. L.

Dried Egg and Salmonella Infection In the January issue of the JOURNAL (p. 428) reference is made to the use of waste dried egg powder in the rations of poultry and growing pigs. In view, however, of the risk of salmonella infection from this source, it is recommended that this material should not be used.

THE MINISTRY'S PUBLICATIONS

Since the date of the list published in the December, 1948, issue of *Agriculture* (p. 411), the undermentioned publications have been issued.

Bulletins Copies are obtainable at the prices mentioned from the Sales Offices of H.M. Stationery Office or through any bookseller.

No. 50 Modern Rabbit Keeping (*Revised*) 1s. 3d. (1s. 5d. by post)
No. 65 Crop Production in Frames and Cloches (*Revised*) 2s. 6d. (2s. 8d. by post)

Advisory and Animal Health Leaflets Single copies of not more than 16 leaflets (four in any one group) may be obtained, free of charge, on application to the Ministry, 1-3, St. Andrew's Place, Regent's Park, London, N.W.1. Copies beyond this limit must be purchased from the Sales Offices of H.M. Stationery Office, net price 1d. each (2d. by post), or 9d. per doz. (11d. by post).

Group II. Pests and Diseases of Farm Crops
(a) Insects and Other Pests
No. 226 Red Spider on Hops (*Revised*)

Group III. Pests and Diseases of Fruit Crops
(a) Insects and Other Pests
No. 154 Fruit Tree Capsid Bugs (*Revised*)
(b) Fungi
No. 81 Peach Leaf Curl (*Revised*)

Group IV. Birds
No. 251 The Cuckoo (*Revised*)

Group V. Weeds
No. 52 The Suppression of Weeds (*Revised*)

Animal Health Leaflets
No. 4 Glanders and Farcy (*Revised*—superseding Advisory Leaflet No. 137)
No. 16 Louping-Ill in Sheep (*New*)
No. 18 Fowl Pest (*Revised*—superseding Advisory Leaflet No. 281)
No. 20 Swine Fever (*Revised*—superseding Advisory Leaflet No. 83)

Marketing Leaflets
No. 102 Recommended Grades for Root Vegetables (*New*) 2d. (3d. by post)
No. 103 Recommended Grades for Broccoli and Cauliflower (*New*) 2d. (3d. by post)

AGRICULTURAL INDEX NUMBER

Monthly Index Numbers of Prices of Agricultural Products Including Government Grants. (Base 1927–29 = 100)

Month	Uncorrected for Seasonal Variation					*Corrected for Seasonal Variation*				
	1939	1945	1946	1947	1948	*1939*	*1945*	*1946*	*1947*	*1948*
January	95	192	199	217†	†241	89	173	179	193†	†215
February	94	193	201	211†	†240	88	176	182	190†	†217
March	91	185	192	201†	†232	91	178	183	191†	†220
April	90	167	176	186†	†214	95	173	182	192†	†222
May	82	154	162	171†	†198	91	173	181	192†	†223
June	80	154	161	170†	†197	89	174	181	193†	†225
July	85	162	168†	181†	†198	93	177	182†	197†	†216
August	86	162	176†	192†	†211	91	174	191†	208†	†228
September	92	159	177†	206†	†210	93	166	188†	222†	†227
October	96	179	192†	221†	†226	92	172	187†	215†	†221
November	106	191	209†	235†	†239	98	177	192†	217†	†222
December	113	197	214†	241†	†246	103	178	192†	216†	†221

† Provisional.

BOOK REVIEWS

Family Farm Policy. JOSEPH ACKERMAN and MARSHALL HARRIS. University of Chicago Press. 22s. 6d.

This large volume, which is a report of the proceedings of a conference held at the University of Chicago in February, 1946, has as its main theme the discussion of land tenure in relation to the family farm in the United States. The work does, however, contain papers on land tenure in twelve other countries, including an essay by Professor Thomas of Reading University on the "Tenure of Agricultural Land in Britain".

Contributors of papers seem to have been particularly reluctant to define the "family farm," and even the general definition put forward by one of the main committees of the conference was not agreed by all its members. It is clear that the term is used in the United States, as elsewhere, to cover a wide range of meaning and, as this conference agreed, further clarification is desirable.

The value of the book might have been enhanced had this conference of seventy-six experts not decided at the outset that the "family farm" was the ideal economic and social unit to be aimed at in any policy of land tenure and had concerned itself for part of the time with an analysis of other forms of organization. Presumably it was thought that the subject was wide enough as it stood.

The object of the conference was "the discussion of ideas basic to the establishment of a sound tenure policy" and not to outline recommendations for specific action. Its field was very wide and the discussions covered, amongst other things, the question of land settlement in family units, limitations on the size of holdings, subdivision and inheritance, capital and the provision of credit, and certain aspects of the law in relation to taxation and to security of tenure. British readers will be interested to note that although the question of compensation to tenants for unexhausted improvements has been a topic of contention in the United States for a long period, little real progress has been made to give it a statutory meaning. One section deals with improvement in condition and in efficiency of farm labour, and British readers may again be surprised at the absence of statutory recognition of rates of agricultural wages and of conditions of work.

Although large, the book is well arranged and has an excellent summary of thirty-five pages prepared by the editors. No comment is required as to the importance of its subject and it forms a useful addition to the library of any student of agriculture and of land economics in particular.

W.J.T.

Nuts : Their Production and Everyday Uses. F. N. HOWES. Faber. 18s.

Although the term *nut*, when used botanically, is applicable only to a certain type of fruit, and in consequence has a strictly limited range of use, in popular language it is applied to an extremely diverse collection of plant products. As this book is concerned with the subject of "nuts" in the latter and wider sense, it is not surprising to find an infinite variety of plants in the author's widely-cast net. "Nuts," we learn, are obtained from many different kinds of plants ; for example, there is the peanut, or groundnut, plant, about which much has recently been heard, and which produces a kind of tough pod or legume.

A great many of these so-called "nuts" are plant products of front rank economic importance today, as witness the big drive now taking place for an increased production of groundnuts. Some—coconuts, groundnuts and oil palm nuts—are the source of valuable fats (oils) which can be used for the manufacture of margarine and soap, and others—walnuts, Brazil nuts, chestnuts, hazel-nuts and almonds—provide highly nutritious forms of human food.

This book, which deals authoritatively with the whole range of "nuts" found throughout the world, constitutes a valuable contribution to our literature on plants of economic importance , moreover it is well written and is illustrated with sixteen plates. The author makes a point of the fact that many plants that are "nut" producers are trees which can be grown as permanent crops without soil tillage. This type of culture is important, particularly in the tropics and sub-tropics, where frequent tillage of unprotected soil is one of the main factors contributing to soil erosion. A chapter dealing with "nut recipes" is also included.

A.H.H.

Profitable Ley Farming. JOHN LAITY. Crosby Lockwood. 15s.

Mr. Laity has produced a very interesting and readable book, packed with the experiences of a thoughtful and observant farmer. It is rich in his love of the land and should be an inspiration to farmers, young and old. It will also provide much thought for the technical and scientific worker, who may not agree with all the author's findings.

Mr. Laity is no stickler for tradition, as instanced by the many practices which he worked out for his own salvation. He pays a warm tribute to Mr. William Borlase, the first Agricultural Organizer for Cornwall, whose classes he attended ; it was Mr. Borlase who introduced him to the Clifton Park System on which his pastures are based, and encouraged him to study the characteristics of the different species contributing to his swards. He tells why he decided to take the plough "right round the farm," and how he set about it. It was not a matter of reclaiming poor, worn-out land, but of farming good land that in grass had been very productive for years.

Farming in a mild district, Mr. Laity believes in feeding the growing crop to stock rather than harvesting, storing, and then feeding it by hand. Of all such crops he concludes that the best is grass. His grazing is planned so that the fattening cattle come first, followed by younger stock and suckling cows. He does not like close grazing but prefers a shaggy appearance, and is opposed to cultivations of almost any kind for pastures, since the returns are insufficient to meet the cost. He remarks, "There is only one cultivator suitable for a bad pasture, and that is the plough".

The seeds mixture advocated is based on the Clifton Park System, some 33 lb. per acre of strong-growing grasses, cocksfoot, meadow and tall fescues, and meadow foxtail with Cornish marl clover and alsike, and with the deep rooted chicory and yarrow Mr. Laity has tried many other species, and damns with very faint praise both perennial ryegrass and timothy. An interesting part of Mr. Laity's experiences is his propagation of cocksfoot, meadow foxtail and tall fescue from some fine specimens which he found growing wild.

Passing from pasture to tillage, Mr. Laity is a firm believer in deep cultivations ; he likes to bring to the surface "a bit of new soil every time the fields are ploughed". He manures heavily, as instanced by 20 cwt. per acre of basic slag, or rock phosphate, for seeds to last several years, and 10-20 tons per acre of sea sand to supply lime. His views on the lime requirement of the soil are perhaps a little exaggerated.

Corn and seeds are sown successfully by the manure distributor. He discusses the erection of buildings suited to the type of farming and says : "I have always made it a practice to train one of the staff to be handy with trowel and mortar". He is also interested in the formation of shelter belts.

Detailed information is given of the many crops tried, and particularly useful in this connection is his technique in the growing and harvesting of early potatoes, spring cabbage, and sugar beet.

Four chapters are devoted to livestock, mainly from the viewpoint of the grazier. Those who may not agree with his cattle breeding methods will, at least, appreciate the thought given to this matter, particularly with reference to polled stock. The sheep policy of the farm covers a period of 60 years and ends with a pedigree registered South Devon flock.

In the last two chapters Mr. Laity ruminates on public activities, from a county show to Young Farmers' Clubs, and, in conclusion, reverts to the maintenance of fertility and good pastures.

The book is well illustrated with examples of various aspects of the activities at Polkinghorne.

A.G.

The Unfolding Year. HOCKLEY CLARKE. Rockcliffe, London. 12s. 6d.

Towards the end of his book Mr. Clarke reflects : "I suppose farming is the one occupation that combines both a way of living and work in one . . . a farmer not only gets a living from the land but it is his mode of existence." That is true. The farmer's way of life is unique and enviable. In many respects he lives in a little world, a microcosm as it were, of his own. For that reason alone there are always readers for a book by a farmer who can write intelligently and simply about his daily life, the round of the seasons, his reflections and his observations. This is a particularly good book of its type. It is the record of a farming year lived by a man who can express himself in simple, artless language that has a peculiar power. Obviously he is not writing of the present time, or for that matter of any time, but nevertheless the reader shares with him the satisfying richness of country life and the ever-changing pageantry of the seasons. Such was its fascination that I could not put the book aside until the last page was read. Many must have found it equally satisfying.

The book is illustrated with numerous delightful drawings by Geoffrey Robinson

A.H.H.

BOOK REVIEWS

Twenty Years of Seed Research at the Boyce Thompson Institute for Plant Research. LELA V. BARTON and W. CROCKER. Faber. 21s.

Researches into problems connected with the germination and storage of seeds have been undertaken by many workers in all parts of the world, but there has been a greater continuous concentration on these problems at the Boyce Thompson Institute for Plant Research, Wisconsin, U.S.A. than at any other single research institute. The authors, whose many contributions to plant physiology have made them world famous, have presented in this book a condensed account of many of the valuable studies on seed germination and seed storage problems undertaken over a long period of years at the Boyce Thompson Institute. The book is in two sections: one deals with studies on certain physiological aspects of seed germination, the other with seed storage and longevity problems.

The "visibly ripe" seed is not necessarily able to germinate readily when placed under conditions of temperature and moisture usually found to be adequate to induce growth, and it is with the researches designed to solve the problems associated with the inability of some seed species to germinate readily under these conditions that the first part of this book is concerned. Fortunately for the agriculturist, few of the species commonly grown on the farm produce seeds which do not germinate readily under normal conditions, though under unfavourable harvest conditions, such as were experienced last year, an inability to germinate soon after harvest is exhibited by a greater number of seed samples of a wider range of species or species groups than in the average year. This section will therefore have a greater practical appeal to the nurseryman, forester and horticulturist than to the farmer, as little of the experimental material forming the basis of the research work described is of species commonly used in farming practice.

The data presented in the second part of the book have a wider practical application as, although many of the species forming the basis of the experiments are not of primary importance in our farming and/or horticultural practice, the conclusions drawn from the work can be applied, in principle, to a very wide range of agricultural and horticultural seeds.

In practice, the major objective in storing seeds is to ensure the retention of the highest possible germination value over the longest possible period. It is well known that seeds of certain species or groups of species will maintain a high level of germination over longer periods than others, but it is not so widely appreciated that, in order to maintain a high germination level, the most vital factors are the temperature and relative humidity of the storage conditions, combined with an initially high germination of the seed. The importance of these factors and their influence on germination behaviour is amply demonstrated in the experiments described by the authors.

The tables and graphs which show the results of many of the experiments are extremely clearly presented and the photographic illustrations are excellent.

C.C.B.

Growth Regulators for Garden, Field and Orchard. JOHN W. MITCHELL and PAUL C. MARTH. University of Chicago Press (Cambridge University Press). 15s.

During the last decade our knowledge of the nature and properties of the growth-regulating substances has made many striking advances. New highly active compounds have been synthesized and novel methods evolved for their practical application. This book aims at summarizing the recent developments and indicating how they can be put to good use by the horticulturist. The authors can speak with authority, since they have either initiated or taken an active part in many of the discoveries.

The main fields covered are the use of the different compounds for selective weed control, the accelerated propagation of cuttings, the control of sprouting and mould attack of stored plant material, the prevention of fruit drop, the stimulation of fruit set, and the production of seedless fruits. This is an impressive list of advances where the use of growth-regulating substances is a practical proposition but, as the authors stress, researches in progress are paving the way to yet wider applications.

The book is addressed to the American gardener and horticulturist, and is naturally concerned with the materials, crops and varieties found in the States. Nevertheless, in the section on the promotion of propagation the comprehensive list of trees and shrubs will be of particular interest to British gardeners. It is a pity that in another list of the reactions of ornamental plants and weeds to the selectively toxic phenoxy-acetic acids the Latin names of species are omitted, since differences in American and English usage of common names leads to confusion and uncertainty.

G.E.B.

BOOK REVIEWS

The Badger. ERNEST NEAL. Collins. 12s. 6d.

Anyone with any knowledge of the subject can form but one opinion of this attractive and well-produced book, which represents a very great advance in the study of the life history of the badger. It is probably the most valuable work of its kind yet published.

It is difficult to decide which of the author's attributes deserves the highest praise—the soundly scientific method of his approach, the meticulous accuracy of his recorded observations, or his zeal and enthusiasm for his task. Any naturalist who has spent nights "on the tiles" in the same cause will appreciate to the full the care, patience and fortitude which that task involved. It is fairly safe to say that no man living has spent more time and labour on the study of *Meles meles* than Mr. Neal.

One of the most remarkable things in this remarkable book is the diagram illustrating the annual cycle of the badger. At a glance the student can see just what the badger does, and when. Hitherto, information of this kind has been meagre and hard to come by. One of the many vexed questions that the author has finally settled is the gestation period of the badger; another is the even more hotly debated question whether the sow badger is able to retard the birth of her young. Both these matters are now put beyond the need for conjecture.

Especially valuable is the information about the movements, breeding and domestic habits and general behaviour of badgers. The author's findings on feeding habits will greatly hearten the steadfast few who find their own experiences amply confirmed, as also their long-standing conviction that the badger as a species is definitely beneficial and that there is no justification for the foolish persecution that has been its lot. As for the illustrations, no nature photographer can fail to admire the wonderful gallery of pictures, and those of us who, among our many failures, have sometimes achieved a single or even a double, gaze with respectful awe at five badgers in one flashlight shot. The frontispiece is undoubtedly unique—the first coloured flashlight photograph of a badger ever taken.

Any student of nature who wishes to know the truth about the badger in so far as the truth is known (and Mr. Neal has gone a long way on that road) cannot do better than to get, read and ponder this book. It should finally explode the contemptible nonsense that is far too often said and written about the gamest, cleanest and least offensive of all our wild mammals.

F.H.L.

Plant Viruses (Second Edition). KENNETH M. SMITH. Methuen. 6s.

So much progress has been made in the study of plant viruses since this little book was first published in 1935 that it has been necessary to rewrite the text for the second edition. It consists in effect of a series of short essays on the symptoms and control of plant virus diseases, on the methods by which they are spread from affected to healthy plants, and on the viruses that cause them—their nature and properties, their relationship to insects that transmit them, their serology, and their classification.

The book is recommended to those who wish to become familiar with the broad outlines of the subject; it is designed particularly for students who have no previous knowledge of viruses. The text is generously sprinkled with references to original work for readers who wish to go further into the subject, and there are about a dozen illustrations.

W. C. M.

Printed in Great Britain under the authority of HIS MAJESTY'S STATIONERY OFFICE by C. Nicholls & Company Ltd., The Philips Park Press, Manchester, London and Reading.

FARMERS' FORUM No 1

"I've been riding tractors since they were pups!"

SAYS HERBERT MOSS, HEAD DRIVER ON MR. BRITTAIN'S HIGHLY MECHANISED FARM AT FELIXSTOWE, SUFFOLK.

"... and for running firmly along the top of the furrow — especially when finishing off, or starting a new stetch — give me the non-slip grip of Goodyear Sure-Grips every time."

FARMING TODAY demands scientific planning and maximum mechanisation. For every job on the farm there's nearly always a short period when weather and soil conditions are ideal. If you are equipped with the tractors and implements to get it done while conditions are at their best, you gain time, and you've got all your resources lined up for the next job.

This is the modern, go-ahead outlook; the outlook that will solve Britain's food problem by making us as near self-supporting as we can possibly be.

Goodyear farm tyres are all designed to get the job done quicker, with less implement "judder". In particular, the Goodyear Sure-Grip Tractor Tyre with its famous o-p-e-n c-e-n-t-r-e tread, gets your tractors through more work in less time than you ever thought possible. Look at those mighty lug-bars! See the bite-points? . . . They dig deep into the ground, followed by the whole length and breadth of the lug-bars. Four-at-a-time those rugged self-cleaning Goodyear bars drive the tractor forward, extracting the uttermost ounce of power from your engine by sheer, down-to-earth *wheel-adhesion.*

Speed the plough with

GOODYEAR

SURE-GRIP TRACTOR TYRES

and grow more food for Britain

Please mention the JOURNAL *when corresponding with Advertisers*

BY APPOINTMENT
MAKERS OF
CHEMICAL
FERTILIZERS

It's Fisons for Fertilizers

Obtainable from Agricultural Merchants or
direct from the following Sales Offices:

Berwick-on-Tweed, Burntisland, Edinburgh, Lincoln, Newcastle, Newport, Widnes, Plymouth, York and

Head Office:

FISONS Limited, Harvest House, IPSWICH

72-1-3-49

Agriculture

PUBLISHED 6d MONTHLY

Please mention the JOURNAL *when corresponding with Advertisers*

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

Editorial Offices : St. Andrew's Place, Regent's Park, N.W.1 (*Phone : WELbeck* 7711)

VOL. LVI | No. 2 | MAY 1949

Contents

Cover Photograph
Badgworthy Water, Exmoor

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LVI No. 2 MAY 1949

WORLD POPULATION AND THE FOOD SUPPLY

JOHN GREEN

WILLIAM VOGT's *The Road to Survival*, recently published in the United States,* sets forth in cogent form a theme that has been dominating a section of American thought for some time. It is a matter that should—but for an amazing lack of geographical interest in this country—have dominated our own thought as a Commonwealth and colonial power. The Americans at least acknowledge what they owe the British—in particular to Malthus, Darwin and Mackinder. They were quick to read Jacks' and Whyte's timely book *The Rape of the Earth* and endorse the recent jeremiads of Sir John Boyd Orr. They have always been aware of soil and climate as the two geophysical factors that ultimately control human existence—perhaps because some of the world's great mountains, forests, rivers, deserts and prairies are within their own economic complex. What is more important—politically, they now hold a surplus of the world's food against the rising populations of Asia, South America and south-east Europe.

The Americans are beginning slowly to realize that the last frontier has been reached and that standards of living are affected by the number of people who must enjoy a given volume of resource. A nation may live in the midst of resources and yet be unorganized to use them, like Tsarist Russia; or it may be organized to enjoy the resources of other lands, like Britain in the nineteenth century, or even sea-locked Venice when she "held the gorgeous East in fee". It may so divide its realized wealth internally that the standard of living is high for one section of the community and low for another. But these political arrangements do not affect the fundamental proposition that the standard of living depends ultimately on the net produce of the lands and mines a people can command. Where there are few people to enjoy the fruits of a territory and they are technically well equipped to win them, the standard of living will be high, as in the white British Dominions; if too many people with a rising birth-rate occupy exhausted territory, the standard will be low, as in India and China. The classical economist assumed that the sources of power and raw material were unlimited, and that human industry was equal in every climate. These assumptions are still tacitly accepted in the Atlantic Charter.

American nutritionists believe that 2.5 acres per head of the population is required for an adequate standard of living. Over the whole continent of Europe, 0.88 of an acre is available. The United Kingdom, the Netherlands and Belgium (albeit colonial powers) have less than 0.3 of an acre. Moreover, it is of interest that those European countries with the highest birth-rates have the lowest standard of living—namely, Rumania, Poland, Italy, and Greece. Greece, with an average grain yield of only 13½ bushels

* Published in this country by Gollancz, price 15s.

an acre, accounts 12 acres a large farm. Italy, which in the mid-'twenties imported 80,000,000 bushels of wheat, had reduced this before the late war by 78 per cent. Despite this tremendous effort of self-sufficiency, Count Sforza said in 1946 that her sole problem was still over-population. In Asia the position is of course worse. From 1600 until 1867 the population of feudal Japan was stabilized at 26,000,000: it is at present estimated to be 79,000,000. Americans have also computed that in China 100,000,000 people have starved to death in the last century.

In India, before the British came, the population was estimated at less than 100,000,000, and was held in check by famine, disease and war. In India today some 400,000,000 people now enjoy a diet of 1,400 calories against the 3,000 calories of 8,000,000 British stock who enjoy twice the area in Australia. In addition to having one-fifth of the world's people, the Indian further embarrasses the situation by keeping one-third of the world's cattle. Even the Soviet Union has a rising spiral of population commensurate with new stages in her industrial development.

In the nineteenth century the New World was able without war to absorb the expanding populations of Europe. Between 1850 and 1940 the population of the world doubled, but the population of the New World, the Americas and Oceania, quadrupled. It is not without reason that much of the best real estate in the New World today is in the hands of Highland emigrants, or that the Irish potato famine found ultimate relief in the gold rushes of the 'fifties. In more recent times Madrassi Indians cutting sugar-cane in Natal have opened the door to the Indianization of East Africa. The danger today is that already crowded countries will not offer asylum to economically displaced persons. The world is slowly recovering from a war of *lebensraum*. Germany wanted the *anschluss* and coveted the Ukraine in order to balance her economy and preserve a standard of living in Europe at the American level. The Japanese sought to lead the people of Asia towards the empty spaces of Australia. However, here is striking testimony that the story is not new:

> Let none of your possessions detain you, no solicitude for your family affairs, since this land which you inhabit, shut in on all sides by the sea, and surrounded by mountain peaks, is too narrow for your large population; nor does it abound in wealth; it furnishes scarcely enough food for its cultivators. Hence it is that you murder and devour one another, that you wage war, and that frequently you perish by mutual wounds. Let therefore hatred depart from among you, let your quarrels and your wars cease and let all dissensions and controversies slumber. Enter upon the road to the Holy Sepulchre; wrest the land from the wicked race and subject it to yourselves.

Those words, as Mr. Vogt sardonically adds, were not spoken at Nuremberg: they were addressed to the Crusaders in 1095 by Pope Urban II.

Problem of Rainfall A factor that appears to obscure the European's perception of human affairs is indifference to rainfall. It has accounted for lamentable plantation failures (not only in the past but apparently at the present time) for extravagant hopes of population in countries like Australia, and for plain misplaced good intentions in colonial administration. We seem to forget that man is 60 per cent water and most of his food is water. This water is derived principally from the oceans by evaporation and precipitated onto the earth according to its topographical features. Mountain barriers and the depth of continents therefore affect climate: but it is also affected by soil temperatures and vegetation. While climatologists are not in agreement on the part transpiration from plants plays in maintaining the cycle of evaporation and precipitation—what they call grandiloquently the hydrologic cycle—

they are agreed that vegetation and forests affect soil temperatures and arrest the run-off of rains. The disappearance of forests in the Mediterranean area has coincided with the decline of several territories, formerly rich colonies of the Roman Empire. Nevertheless, wherever the European has appeared in the New World, his settlement has been preceded by fire and the axe ; so that the loss of timber is as much regrettable as its possible effect on the rainfall and climate.

The deterioration of grazing lands is considered to be as serious as the removal of timber. This insidious, economic loss is perhaps less spectacular than forest denudation. The western range lands of the United States comprise nearly 800,000,000 acres and support almost 75 per cent of the nation's sheep and over 50 per cent of its cattle. Formerly thronged with buffalo and the hunting-grounds of the Indian, their grazing capacity was raised by the white American to some 25,000,000 head. In 1935 it was estimated that over-grazing had reduced this capacity by half. Today some 35 per cent of the feed for western livestock comes from croplands or irrigated pastures ; while in Texas the use of commercial feed has increased by 400 per cent since 1906. It is suggested that these facts alone would account for the price of steak in the restaurants of Chicago and New York. In Australia there has been a corresponding decrease in the carrying capacity of the inland grazings. Although the sheep population has increased as the result of closer settlement and the reduced size of holdings, the true cost of producing merino wool must have increased considerably with the disappearance of saltbush, mulga and other edible shrubs. I need hardly stress that the carrying capacity of our own hill-lands has fallen progressively since the 'seventies through "extractive" farming practices. That was the conclusion in the Report of the Committee on Hill Sheep Farming in Scotland, published during the war.

Next in economic importance comes soil erosion. The world's topsoil is removed by either "gully," "sheet" or "gravity" erosion. Gullying occurs wherever man cultivates undulating and sub-humid soils which are subject to periods of intense rain. Incipient gully erosion can be arrested by contour ploughing, but this adds to the permanent cost of cultivation like drainage in the heavy soils of Britain. Gullying affects much of the world's wheat land. I have personally seen vicious examples in the fertile Palousse district of Washington State ; in New South Wales ; and in South Africa in the Western Cape. I have seen much worse in summer rainfall grazing areas where the value of the land did not justify conservation practices. There canyons twenty feet deep were scoured bare to the rock and the capacity of dams built to conserve water was entirely lost by siltation. By contrast, sheet or wind erosion may not be so spectacular, but it is the means by which dustbowls are formed. There is the reputed gesture by which Dr. Bennett wiped the soil of the Middle West off the window-sill in Washington and so persuaded Congress to inaugurate its Soil Conservation Service. The outstanding example in the British Commonwealth was the identification of Australian soil particles on the snow of New Zealand, 1,500 miles across the Tasman Sea. Gravity erosion occurs when steep slopes are uncovered and the soil seeks its natural angle of repose in hideous avalanches—this is often found in the tropics, and much grazing land in the North Island of New Zealand has been irreparably damaged in this way.

In Britain—apart from certain light fens—we do not experience soil erosion, because of the low rate of evaporation which results from our cloudy atmosphere. We do, however, suffer severe leaching of soil nutrients through rain. Before the war our use of nitrogen on farm land was some 68,000 tons, whereas last year it had increased to 185,000 tons. Month

by month we claim a new record of milk production, but this represents a daily drain from the soil of calcium and phosphate. An American has claimed that after forty-five years of cultivation the virgin soils of Ohio, Wisconsin and Illinois have lost 36 per cent of natural phosphate. New Zealand exports her staple products of lamb and butter to this country only by the most prodigal use of Pacific phosphates.

If, therefore, it is true that there is loss of carrying capacity in the earth's surface and at the same time an increase in population, can the situation be improved? So much emphasis is laid on birth control that one almost infers a body of Washington opinion in favour of it as a principle of United States policy. Mr. Vogt boldly poses the issue of: no aid without contraception. However, I do not believe that the quality of mercy could be strained to that extent by any wealthy people in an ignorant world—not, at least, until they have turned off their own taps, cut down their superfluous newspapers, and abated their immense enthusiasm for plumbing. But I do suggest that a profound moral consideration is posed by these American conservationists—if perhaps overlooked in their enthusiasm for more specious theories or facile solutions. Mr. Vogt really states his moral position when he writes:

> One of the strangest lacunae in human cultural development is the absence of understanding of man's relationship to his physical environment. So anthropocentric has he been that, since he began to achieve what we call civilization, he has assumed that he lives in a sort of vacuum.

Anthropocentricity Surely that word anthropocentric is the knot in the whole entanglement. Birth control may stop a human being existing, but it will not change the anthropocentricity of those who pass its barriers. False values must still be eradicated in the mind of civilization by self-examination and education. Teachers and moralists must believe that man has other duties than towards man and society in the abstract. I suggest that no amount of individual or social egocentricity or eccentricity can warp our attitude so much as this anthropocentricity. How else can we account for the present-day spectacle of our idealists standing in deserts of their own neglecting, while our materialists are daily hoist on the spoil heaps of their own meddling? Nor is indifference to environment an intelligent position in the post-Darwinian world. Religion and science that do not engender a respect for the physical environment surely deny the grandeur of human purpose. To foul one's nest is a term of maximum opprobrium, yet civilization today appears to lack any ethical standard that even makes such behaviour undesirable.

AGRICULTURE IN CANADA

2. EDUCATION, RESEARCH AND GOVERNMENT

J. A. Young

Assistant Agricultural Adviser, Ottawa

THE first of these two articles appeared in last month's issue of *Agriculture* and gave a general description of farming conditions and systems of farming in Canada. A general idea of the organization of the Dominion and Provincial Departments of Agriculture is almost essential to an understanding of the organization of Canadian agricultural education and research.

The Agricultural Departments There is no hard and fast line between the fields of work of the Dominion and Provincial Departments of Agriculture, but generally speaking the Dominion Department concentrates on matters affecting the nation as a whole, e.g., research and experimental work, national production planning, and inter-provincial and overseas marketing, while each Provincial Department is concerned more with matters affecting its own province, such as executing production plans, and education and advisory work. In actual practice, however, the Dominion and the Provincial Departments work in co-operation on most forms of official agricultural work, sometimes one being the initiating or directing party and sometimes the other. Besides the Dominion Department of Agriculture, the universities and agricultural colleges (which are under provincial control) also conduct agricultural research, but the Provincial Departments of Agriculture scarcely enter this field.

The Dominion Department of Agriculture is organized into five main services:

PRODUCTION. This service administers the Government's agricultural production policy, including animal quarantine regulations, the eradication and control of livestock diseases, livestock and poultry improvement, crop improvement, controls relating to quality of seeds, fertilizers, feedingstuffs, etc.

MARKETING. All the Government's agricultural marketing legislation and policy is administered by this service, including economic research, dissemination of information on markets and prices to farmers and on food regulations and supplies to consumers, grading and inspection of livestock, vegetables and other products going across provincial boundaries or for export, etc.

EXPERIMENTAL FARMS. There are Experimental and Illustration Farms in every region conducting investigations to develop the best yielding and highest quality varieties of farm and horticultural crops, the most efficient methods of producing and harvesting crops, the improvement of the fertility of the soil, and the breeding and feeding of poultry and livestock.

SCIENCE. This service has laboratories in all the main regions of the country. It carries out research in all aspects of plant and animal diseases and insect pests, agricultural chemistry and bacteriology, and administers the various regulations for preventing the entry and spread of plant diseases and pests.

INFORMATION. Experimental and research findings of the Department are conveyed to farmers and housewives, and to extension workers serving these, through bulletins, exhibits, documentary films, etc. The service is responsible for general publicity and public relations, and includes the Departmental Reference Library for research workers in the Department and in agricultural colleges.

In addition to these services within the Dominion Department of Agriculture, there are two other agencies operating under the jurisdiction of the Dominion Minister of Agriculture. These are the Prairie Farm Rehabilitation Administration, whose chief aim is to overcome the effects of drought and soil drifting in the prairies by the expansion of irrigation and the construction of dug-outs and stock-watering dams, as well as the establishment of community pastures on sub-marginal land, and the Prairie Farm Assistance Administration, which makes payments to farmers in areas of the prairies where very low crop yields result from drought, insect damage, etc.

Alongside the above permanent structure of the Department of Agriculture are the Meat Board, Dairy Products Board, and Special Products

Board, which are responsible, respectively, for administering export contracts in and controlling the marketing of beef, bacon, dairy products, eggs, poultry, fruits, vegetables, and seeds. These Boards consist largely of senior officials of the Dominion Department of Agriculture ; they were appointed by the Minister of Agriculture at the beginning of the war and are still functioning.

A Wheat Board under the Department of Trade and Commerce was in existence before the war and still administers export contracts and controls the marketing of wheat.

University and College Education There are eight Canadian universities which award a degree in agriculture (B.S.A.—Bachelor of Science in Agriculture). In each of the three prairie provinces and British Columbia the course for the degree is given in the Agricultural Faculty of the provincial university. In Ontario the degree course is given at the Ontario Agricultural College at Guelph, which is run by the Ontario Department of Agriculture and affiliated to the University of Toronto for degree purposes. In the province of Quebec there are three agricultural colleges: Macdonald College, which is English-speaking and affiliated to McGill University in Montreal; l'Institut Agricole d'Oka affiliated to the University of Montreal, and l'Ecole Supérieure at Ste. Anne de la Pocatière, affiliated to Laval University, Quebec City. The last two are French-speaking. The Nova Scotia Agricultural College caters for the needs of the three maritime provinces, and its students generally finish their degree courses at Macdonald College or the Ontario Agricultural College. There are two veterinary colleges, the Ontario Veterinary College at Guelph and l'Ecole de Médecin Vétérinaire at St. Hyacinthe in Quebec. In all cases the course for an agricultural or veterinary degree extends over four years.

With the exception of Quebec, there are very few agricultural schools in Canada corresponding to the farm institutes in the United Kingdom. However, most of the universities and colleges mentioned give a two-year course (in addition to their degree course) for men who wish to return to the farms. In Alberta similar two-year courses are given at the agricultural schools at Olds and Vermilion. Quebec has about twenty residential schools giving farmers' sons one-year courses.

Research Work Agricultural research is carried on by the aforementioned agricultural colleges and agricultural faculties of the universities, by the National Research Council (e.g., processing and utilization of agricultural waste products), by Provincial Research Foundations, and by commercial firms, but the greater proportion of agricultural research in Canada is carried out and paid for by the Dominion Department of Agriculture. The bulk of the Department's agricultural research work is carried out by the Experimental Farms Service and the Science Service, the main exception being economic research, which is the responsibility of the Economics Division of the Department's Marketing Service.

It is difficult to draw a line of demarcation between the Experimental Farms and Science Services. In general, however, the Experimental Farms Service does more field and applied work than laboratory work, while the reverse is true of the Science Service. The former is organized along commodity lines, and the latter along fundamental science lines. The Experimental Farms Service is divided into the ten divisions of Field Husbandry, Soils and Agricultural Engineering; Cereals; Forage Crops; Tobacco; Fibre; Horticulture; Animal Husbandry; Poultry; Bees; and Illustration Stations. The six main divisions of the Science Service are Entomology, Botany and Plant Pathology, Chemistry, Bacteriology and Dairy Research,

Animal Pathology, and Plant Protection (a control division with powers to prevent entry and spread of specific plant pests and diseases).

The Director of each service, together with the chiefs of the divisions mentioned and staff specialists in each division, are located in Ottawa. The Experimental Farms Service has twenty-four Branch Experimental Farms or Stations, two forest nurseries, thirteen sub-stations, eight branch laboratories, and over two hundred Illustration Stations scattered across the country, while the Science Service has about forty regional laboratories in different areas.

To attempt to cover the entire field of agricultural research in Canada would be out of the question, but it may be helpful to mention a few research problems and projects. Although the tendency is for the different specialists to work more and more in teams, for the purpose of these notes the work will be divided into five parts : soils and climate, crops, livestock, processing and marketing, and economics.

SOILS AND CLIMATE The Experimental Farms Service (Division of Field Husbandry, Soils and Agricultural Engineering), in co-operation with soil scientists of the agricultural colleges and universities (or, in some cases, Provincial Departments of Agriculture), is conducting a nation-wide soil survey and classification. So far approximately 214 million acres have been surveyed, largely through the reconnaissance type of survey. Of this area, 135 million acres are occupied and about 77 million acres cultivated or improved farm land.

Valuable work on the micro-biology of soils is being carried on by the bacteriological laboratory of the Science Service in Ottawa. Studies in soil nutrients are in progress at many centres, e.g., radio-active phosphorus is being used at the University of Saskatchewan ; the University of Alberta and the Dominion Experimental Farm at Lacombe, Alberta, have obtained marked results from sulphur applied to grey wooded (podsolic) soils in northern Alberta ; workers of the Science Service laboratories and Dominion Experimental Farm at Summerland, British Columbia, found that boron deficiency was the cause of serious trouble in the orchards of the Okanagan Valley of British Columbia ; various workers have shown that artificial fertilizers give little or no response on the prairies in dry years ; work has been done at Macdonald College, Ste. Anne de Bellevue, Quebec, on phosphate fixation.

At the Soil Research Laboratory of the Dominion Experimental Farm at Swift Current and at the Soil Mechanics Laboratory located at the University of Saskatchewan, the Prairie Farm Rehabilitation Administration is carrying out work on soil mechanics and soil moisture—crop growth relationships. The prevention of wind erosion of prairie soils has been and remains a major problem, and directly or indirectly engages the attention of many workers, including agricultural engineers, crop husbandry specialists, plant breeders, entomologists and plant pathologists. The most spectacular development in this field has been the replacement of the plough by the one-way disc and other implements that leave the old straw and trash anchored on the surface to protect the soil from blowing, i.e., "stubble mulch" farming. Work on farm mechanization occupies a prominent place at the Dominion Experimental Farms at Ottawa and Swift Current.

All the Experimental Farms across Canada are trying out different crop rotations ; existing practices are not so firmly established as in the United Kingdom. Coupled with this, water erosion of soils is receiving increasing attention and is the subject of work by the Central Experimental Farm at Ottawa. In general, rain falls more violently in Canada than in the United Kingdom, thus increasing the extent of soil erosion, particularly where row

crops, such as potatoes, maize, etc., are grown too frequently. Drainage is also gradually becoming more important in Eastern Canada and has been studied at Macdonald College, Quebec.

Irrigation research work is carried on at two main centres—the Experimental Stations at Lethbridge in Southern Alberta and Summerland in British Columbia. The former is the centre of the main prairie irrigated area (growing sugar beet, peas and other canning crops), while the latter serves the specialized apple (and other fruit) area of British Columbia. At Summerland and in many commercial British Columbian orchards the movable aluminium pipe sprinkler system of irrigation is in operation.

The Ontario Research Foundation, Toronto, is doing very valuable work on the classification of the climates of Canada based on the new Thornthwaite formula. Experiments to measure evapotranspiration (evaporation plus transpiration) in different areas are at present in progress.

CROPS AND GRASSLAND One of the most important aspects of agricultural research work in Canada has been plant breeding. At first the main search was for a spring wheat variety that would ripen early enough to avoid damage from the early autumn frosts of the prairies. Later, attention had to be turned to finding Rust-resistant cereal varieties, and the work of the Dominion Rust Research and Cereal Breeding Laboratory in Winnipeg in this field is world-famous. Later still (in 1947) a new wheat variety ("Rescue") with a solid stem and resistance to sawfly attack was introduced. The counteraction of the wheat stem sawfly is now a major problem in the prairies and is being tackled by a team of workers at the Dominion research laboratory in Lethbridge, Alberta. Rigorous tests for milling and baking quality are applied to all potential wheat varieties.

In Eastern Canada, resistance to lodging is very important in cereals, and a comprehensive study of this subject is at present being conducted by the Cereal Division of the Experimental Farms Service. The approach is to think of resistance to lodging in terms of the root system rather than the strength of straw. At the University of Manitoba the microbiology of grain in relation to heating is being investigated.

Forage crops are becoming increasingly important in Canadian farming. In the prairies one of the main essentials of a forage plant is resistance to drought. A big step forward was the introduction of crested wheat grass by the Dominion Forage Crop Laboratory in Saskatoon. Breeding and selection work with grasses and clovers is in progress at practically all agricultural research centres in Canada. Important research on Crown Rot and Wilt of alfalfa (lucerne) is going on at Lethbridge, Alberta. Outstanding work in the breeding of early maturing varieties of hybrid maize and soya beans has been done in the Forage Crops Division of the Central Experimental Farm at Ottawa, and, as a result, the area where these crops can be grown successfully has been greatly extended.

A co-operative potato breeding project between the Dominion Experimental Farm and the Entomology and Plant Pathology laboratories of the Science Service is in progress at Fredericton, New Brunswick. Here resistance to late Blight, Bacterial Ring Rot, Common Scab and virus diseases are top priorities in research. Control of aphides on potato crops is also being studied.

Apple and other fruit tree breeding work is carried out at the Central Experimental Farm at Ottawa and at the Experimental Farms at Summerland (British Columbia), Morden (Manitoba), and Kentville (Nova Scotia). At Summerland and Kentville, diseases and pests of fruit trees are studied in Science Service laboratories, the work at Kentville including a long-term study of the insect population of apple orchards. Work on virus diseases of

small fruits is done at Science Service laboratories at St. Catharine's in the Niagara Peninsula of Ontario, while fruit breeding work and a long-term study of the effects of cultural practice, spraying, etc., on the insect population of orchards are being conducted at the Provincial Experimental Station at Vineland, Ontario. The Science Service laboratory at Harrow, Ontario, carries out work on diseases of sugar beet and greenhouse crops.

Good work has been done on fruit tree spraying equipment at Summerland, British Columbia : as a result, a new sprayer which completely eliminates the handling of a hose has recently been put on the market.

Biological control work is performed at the Dominion Entomological Laboratory at Belleville, Ontario. The Dominion Laboratory of Plant Pathology in Saskatoon has done work on anti-biosis, e.g., a bacterium which is anti-biotic to root rot of cereals has been found. Work on the toxic principles of plant disease is going on at Macdonald College.

LIVESTOCK Various aspects of animal nutrition feature prominently in Canadian agricultural research. The large volume of work on pig nutrition done at Macdonald College has received wide recognition, while much good work on digestibility of livestock feeds and on the biological value of proteins has been done in Ottawa by the Chemistry Division of Science Service in co-operation with the Animal Husbandry Division of the Experimental Farms Service. A new animal nutrition laboratory has been set up at the Experimental Farm at Lethbridge to deal with special prairie nutrition problems. A biological laboratory for vitamin assays has been functioning in Ottawa since 1940, and the role of vitamins in poultry nutrition has been studied intensively at the Ontario Agricultural College and at the University of British Columbia in Vancouver.

Work on animal diseases and pests is going on at a number of centres, e.g., the animal pathology division of Science Service has done work on mastitis, contagious abortion, swine fever, coccidiosis of poultry, etc. The Ontario Veterinary College at Guelph, the Dominion Research Laboratory at Lethbridge and the Dominion Experimental Farm at Lacombe have worked on rhynitis, a relatively new disease of pigs. The biology of warble flies has been comprehensively studied at the Dominion entomological laboratory at Kamloops, British Columbia. The prairie regional entomological laboratory at Lethbridge has done similar work on the biology of horse bots and on the control of warble flies and other insect pests of livestock. The control of warble flies by high pressure spraying is now a common practice on prairie farms and ranches.

The development of a new breed of sheep—the Romnelet—is in progress by the Experimental Farms Service in the prairies. It is a result of crossing Romney Marsh rams and Rambouillet ewes. The aim is to find a sheep with the ranging ability of the Rambouillet but with better quality meat and wool. In north central Alberta the Experimental Farms Service has made headway in the development of a new type of animal (the Cattalo) by crossing domestic cattle with the buffalo. The aim here is to combine the hardiness of the buffalo with the meat quality of domestic cattle and produce a good animal for the more northerly areas.

Several new breeds of poultry have been produced at the Central Experimental Farm in Ottawa and at the University of British Columbia. Doubts have been cast on the ability of the progeny test to raise the standard of existing poultry breeds. In the case of pigs all efforts are concentrated on the Yorkshire (Large White) breed. The Experimental Farms Service has an extensive pig breeding programme aimed at securing further improvement in bacon quality through progeny testing, inbreeding and line breeding.

Processing and Marketing Because Canada is an exporter of agricultural produce, a good deal of work has been done on the processing and packing of agricultural products, e.g., the National Research Council has worked on the production of butylene glycol from wheat (for synthetic rubber production) and on the malting quality of barley. The industrial utilization of wheat straw is being investigated at the Council's prairie regional laboratory in Saskatoon. This laboratory was set up primarily to investigate the utilization of waste agricultural products, mainly through fermentation processes.

The Council has also done work on the curing and smoking of bacon, meat storage and transportation (including dehydration and canning), manufacture of dairy products, dried egg production and preservation of shell eggs. The Horticultural Division of the Experimental Farms' Service both in Ottawa and Summerland (British Columbia) has done work on the storage and processing of fruits, including juice production, dehydration and quick-freeze methods. The Science Service has worked on the bacterial aspects of processed foods and on problems such as rancidity in Cheddar cheese, etc.

Economics The Economics Division of the Dominion Department of Agriculture conducts research in all provinces, mostly in co-operation with the agricultural economists of the universities but also with Provincial Departments of Agriculture and other bodies. This covers a wide field, including farm and ranch management surveys, land settlement, land use and classification, farm finance, marketing, agricultural co-operation, consumer demand and rural welfare. The Division is also concerned with domestic and foreign agricultural policy. It publishes numerous reports resulting from these research studies and, in addition, contributes three regular periodicals dealing with economic aspects of Canadian agriculture and activities in other countries that might be of interest to Canadian farmers and agricultural officials.

Farm Advisory Work Farm advisory work, or extension work as it is called in Canada, is the responsibility of the provinces. Each Provincial Department of Agriculture, therefore, has its own Advisory or Extension Service. The Dominion Department of Agriculture does not have an Extension Service but it gives much help to the provincial advisory staffs through its laboratories, Experimental Farms and Illustration Stations across the country and through its technical leaflets and bulletins, e.g., a common summer feature of extension work is the field day arranged co-operatively by the Dominion and Provincial staffs at one or other of the Experimental Farms or Illustration Stations, where new practices, new crop varieties and experimental results are seen by and explained to farmers.

The organization of advisory work varies in detail from province to province, but, generally speaking, there is an office in each county with one man and sometimes an assistant to do the work in that county. Normally there are not separate county or district advisers for poultry and horticulture, each advisory officer being responsible for these as well as for general farming. In practice, however, much of the horticultural production is in specialized areas, and in these areas the advisory officer is usually specially trained in horticulture.

Quebec, with more than one agronome (district or county advisory officer) to every one thousand farms, has the most intensive advisory service of any province in Canada. In some other provinces each county or district advisory officer (or agricultural representative, as he is commonly called) has

up to three thousand farms in his area, while in Canada as a whole each advisory officer has an average of slightly less than two thousand farms.

Quality of Produce No attempt will be made to describe all the work of the Dominion and Provincial Departments of Agriculture, but it would be remiss not to mention Canada's leading position in the standardization of agricultural products. This emphasis on quality, achieved largely through co-operation between agricultural producers and processors and the Government (but, in the last analysis, through compulsory grading and inspection), has been necessary to enable Canada to compete in distant markets against producers and processors on the spot and has been largely responsible for the high reputation built up in the United Kingdom for Canadian agricultural produce.

Government legislation to protect domestic consumers against low quality produce dates from before 1700, while as early as 1794 an Act was passed in Nova Scotia (then a separate colony) designating grades for, and providing for official inspection of, salted beef and pork for export. From 1800 onwards a number of Acts were passed in the different territories that now make up Canada, providing for grading and inspection of various products, including cereals, flour, pork, beef, butter, etc. In 1873 (six years after confederation), most of the previous legislation was consolidated in one Dominion Act. Since 1900 the scope and volume of the work has been broadened by a succession of different Dominion (and Provincial) Acts ; for example, at present the list includes the Canada Grain Act, the Fruit, Vegetables and Honey Act, the Maple Sugar Industry Act, the Dairy Industry Act, the Cheese and Cheese Factory Improvement Act, the Livestock and Livestock Products Act, the Cold Storage Act, the Meat and Canned Foods Act and others. Under these Acts, all the main agricultural products, including cereal grains, flour, livestock and livestock products, dairy products, poultry, eggs, fruit, vegetables and canned goods are subject to grading and inspection. Generally speaking, grading and inspection are compulsory for all products going for export, while in the case of home consumption they are compulsory for some products and voluntary for others.

The Acts mentioned also enable other aids to high quality to be provided by the Department of Agriculture ; premiums are paid on cheese above a certain standard of quality, arrangements are made for refrigerated railway cars for transporting butter, cheese and eggs, construction of cold storage warehouses is subsidized, and the operations of processing plants are supervised.

The Marketing Service of the Dominion Department of Agriculture is a large organization responsible for the grading and inspection and other aids to quality mentioned above in respect of products for export and for despatch across provincial boundaries. The Provincial Departments of Agriculture have the authority in respect of products which are produced and remain within their boundaries, but in many cases they use the same grade standards as the Dominion Department and either authorize the Dominion inspectors to do their work too or co-operate with them so that a uniform policy can be carried out for all products.

Efforts to ensure uniform high quality products are not confined to marketing alone. The Production Service of the Dominion Department of Agriculture and the Provincial Departments of Agriculture are striving to raise quality at the production end; e.g., the litter-testing stations across the country and the Advanced Registry Service for swine have done much in the last twenty years to raise Canadian bacon to its present high standard. Many other examples of this type of work could be quoted, such as the certification and distribution of pedigree seeds, animal disease control work,

and financial assistance to breeders for high quality sires and to agricultural shows and exhibitions.

Altogether it may be said that Canada is justly proud of her achievements in producing and marketing agricultural products of high quality.

The help of Dr. J. F. Booth, Mr. S. R. N. Hodgins, Dr. E. S. Hopkins and Dr. K. W. Neatby of the Dominion Department of Agriculture, Ottawa, who read a preliminary draft of this article and suggested many valuable amendments, is gratefully acknowledged.

SELECTIVE WEED CONTROL IN CARROTS AND RELATED CROPS

Professor G. E. Blackman, M.A. and G. W. Ivens, B.A.
Department of Agriculture, University of Oxford

As soon as it was learned that in both American and Australian field trials annual weeds in carrot crops had been successfully killed by spraying with light mineral oil fractions, similar investigations were initiated in England during 1945, as part of the programme of research on weed control supported by grants from the Agricultural Research Council. At that time the oils which had been used extensively abroad appeared to come within the range of burning or vaporizing oils. For the first tests the oils of these types most readily available were Pool burning oil and Pool tractor vaporizing oil, but it soon became clear that the specifications which satisfied requirements for oil stoves or tractors were by no means sufficient to ensure that such oils were effective and selective herbicides for killing annual weeds in carrots.

Finding the Most Effective Mineral Oil That there should be considerable variability was not altogether surprising, since, in the procedure of storage and handling under war-time conditions, oils from different refineries in the world were bulked together. Some of the difficulties that arise when oils are either mixed together or selected by chance are well illustrated by the results of one of the early experiments. A comparison was made between a standard tractor fuel and mixtures containing a quarter, a half, and three-quarters of burning oil. These were sprayed on seedling carrots infested with annual meadow grass (*Poa annua*), and the results of counts subsequently made on both the weeds and the crop are set out in the following table.

Comparative Efficiency of Vaporizing Oil, alone and mixed with Burning Oil, for the Control of Annual Meadow Grass in Seedling Carrots

Proportion of Oils by Volume		Total Aromatics	Percentage Kill	
Vaporizing	Burning	Percentage Content	Annual Meadow Grass	Carrots
100	0	20.0	98	85
75	25	18.3	97	0
50	50	16.5	80	0
25	75	14.8	69	17

The experimental findings can be summed up as follows : with a chance selection of tractor fuel one may kill all the weeds and most of the carrots, while by mixing tractor fuel and burning oil in various proportions one can kill some of the weeds and some of the carrots or all the weeds and none of the carrots. At this period of the investigation it was generally held that the selectivity of the oils was linked with the "aromatic" content. When the aromatic content was too high there was a risk of killing the carrots, and when too low the weeds were not destroyed. Re-examining the results from this viewpoint, it is clear that this approach is not very revealing. It is the oils with the highest and lowest aromatic content which have caused the greatest injury to the crop.

Further experiments carried out in 1946 and 1947 confirmed that the suitability of an oil could not be judged on the aromatic content alone and that the variation within vaporizing or burning oil samples was too great to warrant their use being recommended generally. On the whole, the burning oils failed to kill the annual weeds, while the vaporizing oils—although more effective against weeds—tended to kill or check the carrots. It is not implied, however, that this was invariably so, because in most of the tests with tractor fuel the benefits of weed suppression offset the check to the crop.

At this stage of the work it was evident both from the English research and parallel investigations proceeding in California and elsewhere in the United States that there was unlikely to be any quick solution to the problem of what constituted selective toxicity in an oil suitable for spraying carrots. This slow progress was hardly surprising, since any petroleum fraction contains a large number of highly complex compounds and the time taken to separate the effects of the different constituents in a range of oils was certain to be very long and the results largely unpredictable. The short-term alternative was to find out empirically by field tests which oils were truly selective in their action and then to ensure that carrot growers received as nearly as possible the same material.

The establishment of this linkage between the experimental tests and commercial practice presents comparatively little difficulty in America, where there are many indigenous oilfields and local refineries ; to maintain continuity in grade and performance, supplies of crude oil can be drawn from a single oilfield and refined into fractions under standard procedures in a single refinery. On the other hand, petroleum products reaching England normally come from oilfields all over the world, and most of the refineries are situated abroad. Therefore, before the research could be continued, oil fractions from specific oilfields and refineries had to be imported specially. As it was possible only to guess what fractions were required, and clearly impossible to test samples from all the larger oilfields and refineries, a selection had perforce to be made. Amongst the oil fractions not yet tested there may, therefore, be some which are equal to or better than those already investigated, and research on a wider range of oils is now being carried out.

The fractions already investigated (apart from burning and vaporizing oils) include kerosenes with a low aromatic content (0.5 to 6.6 per cent), kerosene extracts with a very high aromatic content (75–85 per cent) and more volatile fractions coming into the category of "white spirit" or "Stoddard solvent," which are normally used for dry cleaning and as paint thinners. These volatile oils were included because it has been found in the U.S.A. that with them there is less risk of imparting an oily flavour to the carrots, even if spraying is delayed until the seedling stage is past. On the other hand, it was realized that such oils in England carry a tax

of 9d. a gallon and that their cost would, therefore, be very high for field-scale use.

So far it has been found that mixtures made up of kerosene extracts and kerosenes with a low aromatic content have killed the widest range of weeds. In fact the best of them were superior to any of the "straight" oils, including a Stoddard solvent type which has been used extensively for weed control in carrots under American conditions. The proportion of kerosene extract must be kept within well defined limits since, undiluted, they are far too toxic to carrots. The optimum results have been obtained by using 15–20 per cent by volume of an 85 per cent aromatic kerosene extract* and 80–85 per cent by volume of either of two low aromatic kerosenes.†‡

Susceptibility of Annual Weeds and Time of Application Amongst the annual weeds which are relatively susceptible the following are listed in approximate order of increasing resistance: annual meadow grass (*Poa annua*), chickweed (*Stellaria media*), speedwells (*Veronica* sp.), fat hen (*Chenopodium album*), henbit dead nettle (*Lamium amplexicaule*), spurrey (*Spergula arvensis*), orache (*Atriplex patula*), shepherd's purse (*Capsella bursa-pastoris*), poppies (*Papaver* sp.), yellow charlock (*Sinapis arvensis*), and annual nettle (*Urtica urens*). Sow thistles (*Sonchus* sp.), fumitory (*Fumaria officinalis*) and groundsel (*Senecio vulgaris*) appear to be very resistant once the plants have attained any size, although a reasonable control of the last two can be achieved by spraying when the plants possess only two to four true leaves. It is not implied, however, that spraying of the more susceptible weeds should be delayed, because the highest degree of weed control will invariably result from spraying as soon as the risk of damaging the carrots has passed.

It is not safe to spray carrots before they possess at least two true leaves, and spraying should cease *before* the plants have developed tap roots as thick as a lead pencil. This is not because the carrots would be damaged by late spraying but because traces of the oil would persist in the plants until harvest time and cause a "taint". Where spraying has been carried out in the early seedling stage, no taint has been detected in maincrop carrots with the oils so far tested. On the other hand, there is a very distinct risk with spring-sown carrots pulled and bunched for the early market that the taint will make them unsaleable.

It seems immaterial whether the foliage of the weeds or the carrots is wet or dry at the time of spraying, since equally good results have been obtained under both conditions. Spraying is more or less "weatherproof", as effective action is not interfered with by rain after treatment. Nor is temperature a factor of importance, except that there is a risk of damaging the carrots if spraying is carried out in very hot weather.

Rate of Application There remains the question of the quantity of oil that is required to give the best results, and here further research is needed. At present it would appear that if the whole area and not only the carrot rows are to be sprayed, 70–100 gallons of oil

---

* Shell Medium Kerosene Extract ex Digboi. Specific gravity 0.925, initial boiling point 224°C., 50 per cent distillation 255°C., final boiling point 290°C.

† Shell Odourless Kerosene. Specific gravity 0.795, initial boiling point 198°C., 50 per cent distillation 238°C., final boiling point 269°C., aromatic content 0.5 per cent.

‡ Manchester Oil Refineries Kerosene W.B. Specific gravity 0.842, initial boiling point 138°C., 50 per cent distillation 205°C., final boiling point 273°C., aromatic content 6.6 per cent.

per acre are needed. If, on the other hand, the carrots are grown in wide rows with inter-row cultivation, the quantity of oil can be decreased by arranging for the individual nozzles on the spray boom to spray single rows, leaving the weeds between the rows to be dealt with by the hoe.

Whatever practice is adopted, the weeds must be completely covered with a film of oil. The rate of application will depend on the stage of growth —susceptible weeds in the young seedling stage may be killed at lower rates than those required by older plants. Once the weeds have reached a height of 5–6 inches, however, little useful reduction in weed cover can be expected, even at the highest rates of application.

When this investigation was started it seemed that the costs of spraying could be greatly reduced if oil-water emulsions could be substituted for undiluted oils. Unfortunately, experiments carried out in 1945-46 produced some surprising and disappointing results. It was found that emulsions were less effective in killing the weeds and much more toxic to the carrots. For example, in one experiment in which an undiluted oil had no effect on carrot seedlings and gave a 98 per cent control of annual meadow grass, a half-and-half emulsion of oil and water destroyed 53 per cent of the carrots and only 65 per cent of the meadow grass—a very interesting result as regards the analysis of toxic action, but hardly one which can contribute to the saving of oil during spraying.

These experiments have been extended to cover the possibilities of weed control in parsnips, and the conclusions reached are very similar to those for carrots. It is essential to spray when the parsnips are young plants with two to four true leaves, and some check to growth may result, for parsnips are rather less resistant than carrots. However, the check does not normally lead to any appreciable reduction in yield at harvest.

Although no experiments have been undertaken at Oxford on weed control in parsley, reports have been received from growers that tractor fuel has given good results when sprayed on the young plants; in view of the great variability in the behaviour of tractor fuels, however, caution is required. The use of the mineral oils at present available is not recommended for weed eradication in celery: the crop is too susceptible.

As the recommended mixtures of oils may not immediately be available in large quantities, growers may wish in the meantime to try out tractor fuel. If this step is taken the only rational policy is first to obtain a bulk consignment well in advance and to try a small quantity on an experimental patch as soon as possible; only if it is clear after about three days that results are satisfactory should the whole field be sprayed. By this means a loss of crop may be avoided, and an oil which fails to kill the weeds in the initial trial can be used in the tractors.

There is little to be said about the actual technique of spraying except to emphasize that rubber diaphragms, hoses, and tanks with rubber linings will be attacked by these oils unless they are made of special oil-resistant mixes. However, in the case of diaphragms and hose eventual replacement is not an expensive item.

MECHANIZING THE CARROT CROP

F. M. Darby, N.D.A.

Norfolk Agricultural Executive Committee

THE carrot crop makes heavy demands upon manual labour, both during cleaning operations and at harvesting. The possibility of mechanizing the crop has consequently been investigated on a light, black fen soil in west Norfolk, where carrots are an important crop and

yields of over 20 tons per acre can be grown easily. Unfortunately, weeds grow vigorously on this type of soil, and the area concerned, being part of a large area of reclaimed fen, is only thinly populated and labour is scarce. The future of the crop in the district thus depends upon an early solution of the labour problem by controlling weeds, by spraying as distinct from hand weeding, and by harvesting mechanically.

To facilitate both operations, drill widths have been standardized to allow easy inter-row cultivations, the reduction of spraying fluid per acre, convenient mechanical harvesting and the possible safeguarding of the crop against light frosts.

A double row system has been adopted, the seed being drilled in two rows 7 inches apart, with a space of 17 inches between each double row. Other row spacings have been tried, but on the type of soil concerned carrots grow to a considerable size ; with spacings less than 7 inches the carrots tend to push one another out of the ground, and it is difficult to remove the tops by mechanical methods. The seeder type of drill, made originally for America but now used in this country, has been found very suitable for carrots, since the flow of seed is regular and, as the drill units are independent, depth control is accurate. Usually these units are more than 7 inches wide, so that for the double row system it is necessary to fix them on a tool-bar in echelon. This is not difficult; and a tool-bar fixed to a tractor with a hydraulic lift makes a useful outfit.

Weed Control Previous experience on this fenland soil has shown that hand weeding must be carried out at least twice, and often three times, in a wet season. Spraying with paraffin, however, although not entirely eliminating the necessity for hand weeding, has reduced it considerably. For the past two seasons commercial P.V.O. has been used, but it will be appreciated that the oil companies operating in this country have little information concerning its weed-killing properties. It has been found essential to experiment on a small area with a sample from each P.V.O. consignment before spraying the whole field. This is most important, otherwise it may be found that either no weeds have been eradicated or that both weeds and carrots have been killed.

The rate of application necessary for a satisfactory kill of weeds depends on their stage of growth, the degree of infestation, and also upon atmospheric temperature. Good results have been obtained even by spraying during rain, but the weeds are slower in dying and a high rate of application (up to 70 gallons per acre) is necessary. On a warm day, with a moderate weed infestation at the seedling stage of growth, very satisfactory kills have been obtained by using approximately 30 gallons of P.V.O. per acre. It may, therefore, pay to await favourable conditions unless weed growth is excessive and vigorous.

This reduction in the quantity of P.V.O. is also rendered possible as a result of the double row drilling, since the spray nozzles can be adjusted to cover the two 7-inch rows and leave the intervening 17 inches to be dealt with by tractor hoeing. Spraying is most effective whilst the carrots are in the two-leaf stage and weeds are small, but the operation can be delayed if the crop is not required for early pulling. Late spraying, however, should be avoided, since crop growth is checked for approximately a fortnight, and there is also the risk of taint. For early bunching carrots, a light proprietary mineral oil is available which should cause no tainting, but it is fairly expensive for the ordinary grower.

Most common fenland weeds are killed—even chickweed, if it is not too large. Fat hen and annual nettle are rather more resistant, but even

these are severely checked and most of them are killed if sprayed when small. Almost any type of spraying machine can be used, but one mounted on a self-propelled drilling and hoeing unit has proved very suitable. Some trouble has been experienced owing to the effect of the oil on the rubber pump valve washers, but this has been overcome by substituting leather washers. The diaphragm and the rubber will last a whole season without replacement, provided a few gallons of water are pumped through the machine at the conclusion of each day's work.

Harvesting Removal of the carrot tops is essential when harvesting is mechanized, and last year a small engine-driven grass mower was used to cut one double row at a time; this was followed by a light three-row baulk harrow to pull the tops into line across the fields. The tops are then heaped by hand, prior to carting to the harvested portion of the field. This year attempts will be made to use a side-delivery rake to simplify the process, but it may prove difficult to prevent the carrots from being scratched out of this light peat soil by the tines.

Following the clearing of the tops, four rows of carrots are pushed together by a small machine with two shares fashioned like large "L" hoes, which turn two double rows of carrots into the intervening 17-inch space. This small implement is mounted directly to a tractor with hydraulic lift, and two men can easily carry out this operation as well as harrowing the tops ahead of the harvester. A potato harvester of the type employing an elevator digger chain, with side elevators leading the crop past a sorting platform and finally into trailers, has proved very successful for lifting, averaging 1½ acres per day on a 20-ton crop. A few small carrots may find their way through the elevators, but the quantity does not exceed that left by hand workers. The harvesting machine itself is operated by one man, with four women around the sorting platform removing odd tops and debris.

The complete system outlined above has been in use for only one season, but it is expected that with greater experience, both with spraying material and in technique, and with further developments of root harvesters, greater progress in the mechanization of the carrot crop will be possible.

WHERE THE HORSE SCORES

T. Jesse Wadlow

Much Wenlock, Shropshire

If the slaughter of foals and other young horses is allowed to continue unchecked, some farmers may get as desperate as the king who exclaimed when in dire need, "My kingdom for a horse!" However, if there were not a farm horse in the country there are farmers who would not worry as long as they were assured of tractors and the fuel and spare parts to keep them going. At the present time the outlook for supplies of these is fairly good, but it is plain that in the event of any disruption of supplies, whatever the cause, farmers owning agricultural horses would be in a more favourable position than those without them.

Adaptability But taking for granted the certainty of supplies of tractor paraphernalia, the horse still remains a valuable aid to farming. One advantage in his employment is that on occasions he can be used for urgent work when the use of tractors would be practically impossible. During the great freeze-up and exceptionally deep snows of

1947 we could not carry out any useful job with a tractor in our district, but the unshod horses proved invaluable in getting food to the livestock, difficult though it was.

Perhaps the farm draught horse shows to best advantage when, around seed times, cultivated land is too wet to carry tractors without harming the tilth, though dry enough for horses. For example, this year we thought early February too early to sow barley on rather strong land 800 feet up. But later, when we did want to sow, a toe forced into the soil indicated that it was not friable enough under the surface to be compressed by tractor wheels; yet it was dry enough for horses. As we did not possess a horse drill we had to wait a fortnight before the field could be sown by tractor.

In fairness to the machine it must be admitted that the extra compression of the soil by the tractor, when dealing with ploughed-up turf and leys, may sometimes be advantageous, because consolidation is then very important—especially for wheat. On very rich soils it may even be desirable to compress heavily with tractors by carrying out cultivations when the soil would ordinarily be considered too wet for them. A similar idea used to be put into effect many years ago by repeating harrowings with horses abreast. Pressure on the soil in such circumstances injures its structure sufficiently to reduce the straw of the crop; in this way lodging is prevented and in consequence the crop yields better. In no case, however, must the soil be so wet as to become puddled, or the grain will neither germinate nor yield well.

Economic Comparison Until 1943 I used one tractor and four or five horses on 200 acres of arable land. Now we use two tractors and two horses on 216 acres and do not seem to get the work done much quicker than before, although much depends on the dryness or otherwise of the season. The tractors are particularly valuable in getting as many fields as possible ploughed over (some only lightly) immediately after harvest, while the two horses do the odd jobs. This enables the tractors to make an uninterrupted thrust at this very important work.

Two tractors and four horses for 200–250 acres of arable land (with proper rootbreaks and short leys) would, I think, be ideal if a good horseman were available. It would be economical to keep the one tractor (nearly new) and the four horses at work as continuously as possible, using the other tractor (an older one) at busy times only. For half the above acreage one tractor and two horses would suffice, but one of the horses might possibly be a breeding mare. In the first case two or three of the horses might be young ones, which—unlike the tractor—would be "growing into money".

When as many as four horses are kept they must carry out some of the heavier cultivations in order to justify the expense of keeping them, and an experienced horseman becomes indispensable. When only two horses are employed, however, they need be used only for the many light jobs and light cultivations which have to be encompassed on every farm, and unskilled or semi-skilled workers are all that are necessary.

Some of the jobs that occur to me for which two horses, under conditions too wet for tractors, can be used, are: drilling beet and other root crops with a drill which scoops the soil upon the seed; drilling wheat with a disc drill; harrowing for various purposes, but especially for covering seed wheat; horse-hoeing clean roots, or even weedy ones the first time over when two hoeings before singling are intended; light rolling; chain harrowing; rolling leys and turf; carrying corn to safety from the combine harvester after heavy thunderstorms; broadcasting MCPA. All these are operations which horses can do without appreciably harming crops or

soil at times when it would be unwise to attempt to carry them out with a tractor. In this way the farm work is kept going without causing "hard places" all along the fields, as tractors are apt to do.

It is generally proclaimed that one of the main reasons why horses are in disfavour is that men who can manage them efficiently are unobtainable, yet one of the reasons why some of us like a few horses is that they can lie out and be fed and driven by unskilled male and female workers. Only when as many as four good working horses are maintained does it become necessary to employ an experienced teamsman regularly.

Undoubtedly draught horses are an asset to farming, and it is extremely helpful to have them at hand in wet or wintry weather for jobs which the tractor is unfit to do. In addition it is advantageous to be able to call upon them for the large amount of dry weather work which they can do so economically. They should not, therefore, be dispensed with just to save the little trouble attached to their organization. Farm horses can be counted an important national asset.

COLORADO BEETLE IN ENGLAND, 1948

C. T. GIMINGHAM, O.B.E., B.Sc. and I. THOMAS, M.Sc., Ph.D.
Ministry of Agriculture and Fisheries

IN 1947 the number of occurrences of Colorado beetle breeding on potato crops in this country was the highest ever recorded and, as mentioned in the account of the situation in that year,* preparations were made to meet further attacks in 1948. As it turned out, however, 1948 provided a welcome contrast, and only 11 instances of breeding colonies were reported compared with 57 the year before; finds of single beetles within the country unassociated with potatoes were also much fewer, though many more were intercepted on ships. Except in a few instances where the evidence was inconclusive, inquiries showed that the single isolated beetles found had come from the Continent with imported produce or on passenger ships, and the small number of field occurrences of the pest indicates that the measures taken in 1947 had been on the whole successful.

It will be convenient to discuss separately the finds of single beetles, those intercepted on ships, and the occurrences of breeding colonies on potatoes in fields and gardens.

Finds of Single Beetles The first discovery of the year was at Bromley, Kent, where on January 18 a beetle was found in a private garden near some bushes which were being dug up and removed; a thorough search at the time and later in the year failed to reveal any more. The second find was a dead beetle discovered on February 5 among old clothes in a travelling trunk from Germany; another dead beetle was found on February 25 with camomile flowers of Belgian origin.

The first live beetle associated with imported produce was found on February 14 in Nottingham market on lettuce from the Perpignan district in the south of France. Subsequent reports of single beetles on or associated with lettuce from the south of France were received from Torquay (March 24), Leeds Market (March 27) and Smithfield, London (March 31). Imports

* *Agriculture* (May, 1948), 55.

from France of lettuce and other green vegetables with foliage likely to harbour Colorado beetles ceased on March 31. On March 25 a single beetle was discovered on Dutch imported lettuce at Mill Hill. Two others were found during the month, one on lettuce at Wembley and another on an allotment field at Wendover ; the origin of these could not be traced with certainty.

During April two beetles were found in a greenstuffs depot at Newcastle and one on a consignment of mixed English and Dutch lettuce at South Shields. On April 28 a report was received of the arrival at a London goods yard of two closed truckloads of Italian lettuces ; on inspection, thirteen Colorado beetles were found on a fraction of this consignment and both vans were immediately locked, sealed and re-exported. It was calculated that if the remainder of the consignment was uniformly infested to the same extent as the sample examined, the two vans probably contained about 2,000 beetles.

Consignments of lettuce from Holland received during the last few days of April continued to be handled until about May 5. During this period four single beetles were found on or associated with Dutch lettuce—all in the London area. The origin of four other beetles found in early May could not be traced with certainty. After this period a few more single beetles were found on such products as fruit and onions, bringing the total for the year associated with imported produce to 38.

Beetles intercepted on Ships and at Ports

It is now well known that beetles can arrive on cross-Channel boats of any type and with any kind of merchandise. The first beetle reported on a cross-Channel boat in 1948 was on May 17 on the S.S. *Redstar* with a cargo of machinery, copper and oil from Antwerp. On the following day the master of the S.S. *Falaise* reported the finding of a number of beetles on board ; this ship had been on a weekend cruise to the French coast and up the Seine. By the time she berthed at Southampton 29 beetles had been handed in by passengers and 8 more had been killed by the crew ; the decks and superstructure had been thoroughly washed down and an intensive search revealed only one more. Reports of one or more beetles on ships or at ports continued to be received throughout May and the first week of June, culminating on June 8 with reports from the masters of four cross-Channel vessels of the destruction of a number of beetles which had been seen to alight on the ships when they were within a few miles of the French coast. In the case of the S.S. *Hampton Ferry* ex Dunkirk, the insects flew aboard when the ship was in the Dunkirk Channel, about five miles from the French coast ; in all 60 were found on this vessel. On the S.S. *Dinard* ex Boulogne "about two dozen" beetles were killed and three were handed to Customs Officers. About 30 were found on the S.S. *Prince Albert* ex Ostend, and an unknown number were killed on the S.S. *Sheperton Ferry* ex Dunkirk. For the next few days beetles were reported on other ships which had been bound for ports in this country from the Continent on June 8 and 9, and there were undoubtedly considerable flights from the Continent out over the sea at this time.

Throughout the remainder of June and during July and August single beetles or small numbers continued to be reported on cross-Channel boats and at the ports, and mention should be made of finds of a few beetles on ships arriving at Liverpool from Spain.

In addition to beetles intercepted on ships from the Continent, it is interesting to record finds on transatlantic shipping ; one beetle was found in mid-Atlantic on the S.S. *Aquitania* bound for Southampton. At West

Hartlepool, Barry and Cardiff respectively on three separate days in July a single beetle was found on cargoes of Canadian pit-props which were being unloaded or which had just been unloaded. On October 4 a dead beetle was found on the American S.S. *Joseph Lee* from New Orleans, and another on November 1 among ship's store potatoes on S.S. *Captain Polemia* with a cargo of timber from Canada.

The last live beetle was found at Cambridge on December 3 on lettuce believed to have been imported from Perpignan. Finally, on December 21 a sealed jar containing an uncounted number of dead beetles was handed in; this had been washed ashore on the Winchelsea beach on December 3 and it is thought that these were beetles collected and killed somewhere on the Continent and subsequently thrown into the sea.

During the year two beetles were found in aircraft—one on June 10 at Northolt in an aeroplane from Brussels, and another on June 28 at London Airport in an aeroplane about to leave for Paris.

The totals of single beetles found during 1948 were :

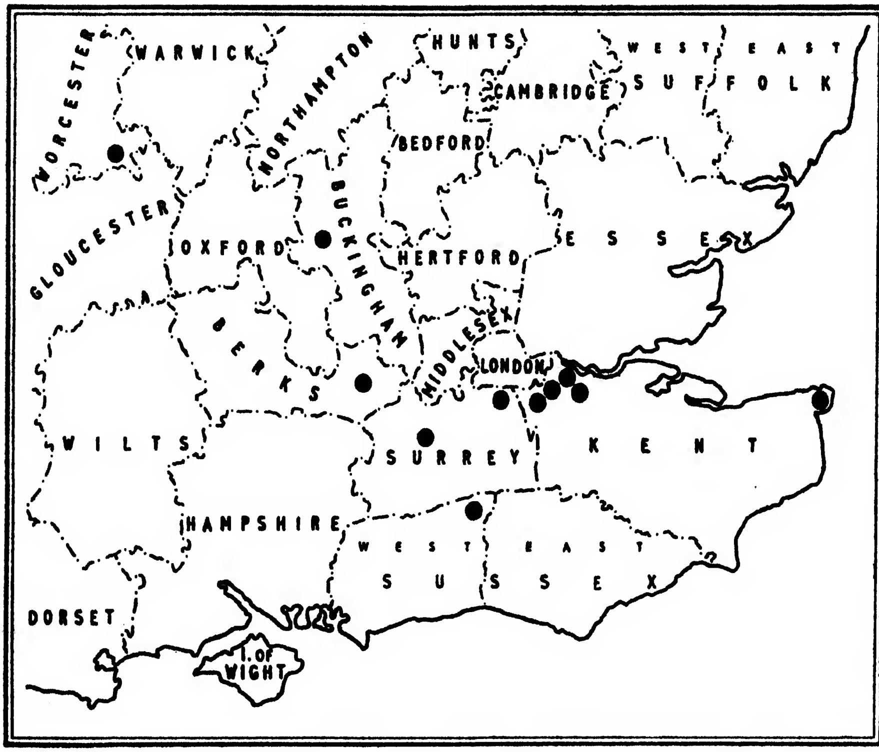
Associated with or on imported produce	38
Intercepted on ships	279 (+)
On docksides and beaches	11
Inland on crops, etc.	17
Others (odd dead beetles, not including those washed ashore in a jar)	7
On aircraft	2

Breeding Colonies Of the eleven breeding colonies found in 1948, five were in Kent, two in Surrey, and there was one each in Berkshire, Buckinghamshire, Sussex and Worcestershire. It is of interest that none was reported in Bedfordshire or Hertfordshire, where a number of attacks gave cause for alarm in 1947.

There were four discoveries before the end of May, the first as early as May 12-14 when, during a hot spell, eight beetles were found on or near a plot of parsnips at Wisley, Surrey. There were no potatoes in the field, and none had been grown there for the past five years. Volunteer potatoes from elsewhere were planted on the plot as traps, and early in June two further beetles and some batches of eggs were found on these plants. Nearby crops were searched repeatedly without result, and then dusted with DDT : nothing further was discovered during the year. It is difficult to account for this occurrence, and the only likely theory that can be put forward is that there may have been an undetected colony in 1947 on black nightshade (*Solanum nigrum*) plants growing on a compost heap which, during the winter, had been spread on the plot where most of the beetles were subsequently found. Black nightshade is one of the few British wild plants on which Colorado beetles and their grubs can feed.

The next occurrence was on May 20 at Winkfield, Berkshire, on a plot sown with onions, on which potatoes had been grown the year before. There were a number of volunteer potatoes on the plot, and some 60 beetles, with many batches of eggs, were found in the next few days—undoubtedly the progeny of a colony which had not been noticed in 1947. The usual measures were taken, including inspection or spraying of all potato crops within two miles ; nothing further was found.

A day or two later, a few beetles were seen on volunteer potato plants among beetroot and carrots on a smallholding at Bengeworth, near Evesham, 8 beetles and some batches of eggs eventually being found within an area of 150 square yards. Constant watch was kept on this plot and careful search of all potatoes in the neighbourhood led to no further discovery, so presumably the beetles were the progeny of a small colony undetected in 1947. All



Map showing location of breeding colonies of Colorado beetle found in 1948.

potato crops in the area were dusted with a DDT insecticide. The last find in May was at Broadstairs, Kent, on early potatoes in a garden where there had been an attack in 1947. Twelve beetles and about 30 batches of eggs were discovered ; one batch of eggs was beginning to hatch on May 31.

On June 11, the discovery of 10 beetles and some batches of eggs on volunteer potatoes in a field of lettuce and peas was reported at Kevington, near St. Mary Cray, Kent, not far from several occurrences in 1947. On the same date beetles and eggs were reported in a large garden at Quainton, Buckinghamshire, partly on volunteer potatoes and partly on the 1948 crop ; in all, about 20 beetles and 50 batches of eggs were found. Later in the month, some eggs were found on potatoes in a school garden at St. Paul's Cray, where there had been a colony in 1947. This and the occurrence at Broadstairs mentioned above are the first instances in which beetles have appeared on sites dealt with in the preceding year.

The next occurrence was on July 13 when a beetle was found on a volunteer potato plant in a field partly planted with lettuce at Dartford, Kent. Search by temporary inspectors showed that numerous grubs were feeding on other volunteer plants over an area of about ¼ acre, and the area was dusted with DDT and injected with carbon disulphide. The only other discovery in July was near the end of the month, when a few grubs were found on potatoes on an allotment at Norbury, London.

No further discoveries were made until August 20, when some beetles were found on volunteer potato plants in a field of cabbage at Darenth, near Dartford. There was no sign of eggs or grubs despite careful search, nor

was anything further found on potato crops in the area. Finally, on September 18, a beetle was found in a 3-acre field of potatoes at Broadbridge Heath, near Horsham, Sussex. The haulm had already been removed and lifting of the crop was carried out under supervision ; nothing further was found. There might, however, have been a colony in this field earlier in the season, and, as a precaution, this was regarded as a case of "beetles breeding".

It will be noted that all the occurrences were on a very small scale and that most of them were on volunteer potatoes, suggesting the presence of colonies on the preceding year's crops and indicating that beetles which emerge in the spring tend to remain on the nearest available food plants. The measures adopted to eradicate the colonies were the same as in 1947 ; they are described in the article in this JOURNAL referred to above. "Trap" crops of potatoes will be grown on the sites this year and will be inspected regularly ; precautionary spraying or dusting of potato crops will also be carried out in the surrounding areas.

Spraying Campaign Field-scale spraying and dusting of potato crops was again carried out for the Ministry by Plant Protection Ltd. Just over 29,500 acres were treated—an acreage nearly three times as large as in 1947 ; of this, all except 177 acres was "precautionary" treatment, planned beforehand. Because of the concentration of occurrences of the beetle in 1947 in the northern half of Kent, all potato crops in the county north of the Folkestone-Tonbridge line (about 20,000 acres) were included. DDT emulsion was used on about 6,000 acres, DDT dust on 7,668 acres, and the remainder received lead arsenate spray. Twenty-seven tractor-mounted spraying machines and twelve dusting machines were employed, in addition to hand sprayers and dusters for small areas. The operations were carried out under difficult conditions because of poor weather, rain often causing delay; an excessive growth of haulm in some areas added to the difficulties. In spite of this, the spraying machines covered an average of 28¾ acres per day and the dusting machines just over 33½ acres per day.

Effect of Weather Weather conditions throughout 1947 had been exceptionally favourable for multiplication of the Colorado beetle. It was known that large populations had been built up at the end of the season on the Continent and that great numbers of beetles of the second generation had gone into hibernation. In the spring of 1948 conditions were again favourable and successful emergence of overwintering beetles took place on a large scale. This was confirmed by the flights that occurred on and near the French, Belgian and Dutch coasts in May and June, resulting in beetles coming down into the sea in large numbers and being washed ashore on the Continent in masses. It is not surprising, therefore, that some beetles reached this country with imported vegetables or other produce in the early part of the year, or that a few were washed up on our coasts. Following the mass flights, there was, as in 1947, a sea-borne invasion of Jersey, but there was again no evidence whatever of direct flights from the Continent to the Channel Islands or to England.

During the remainder of 1948 the weather on the Continent was cold and wet and did not favour the beetle. A high proportion of the young grubs perished, and this, combined with the effects of active control campaigns in the countries affected,† led to a greatly reduced second generation, estimated,

† V. E. WILKINS. International Scheme for the Control of Colorado Beetle. *Agriculture* (October, 1948), 307.

in the area near Paris, to have been not more than one-sixth of the numbers in the preceding year. Similarly in England the weather was our ally, and there is at present less reason to fear the early establishment of Colorado beetle as a pest in this country than there was at the end of the 1947 season.

Action this Year There are, however, no grounds for complacency or relaxation of effort, and preparations have been made by the Ministry for precautionary spraying or dusting of potato crops in the danger areas in 1949 on about the same acreage as last year. The co-operation of farmers and the general public is as necessary as ever in reporting any occurrence, or suspected occurrence, of Colorado beetle at once to the police or to officers of the National Agricultural Advisory Service, or direct to the Ministry's Plant Pathology Laboratory, Milton Road, Harpenden, Herts.

We shall be able to prevent the pest gaining a foothold only by continued vigilance and prompt notification of discoveries so that the necessary steps can be taken immediately. It is again emphasized that if a colony of grubs or beetles is found and reported nothing more should be done until the arrival of an officer of the Ministry. The co-operation and help received in 1948, especially from the masters and crews of ships calling at Channel ports and from the police, is gratefully acknowledged by the Ministry, and once again an appeal is made for its continuance. Tribute is also paid to the excellent work of the temporary inspectors employed during the summer, and to the staff of Plant Protection Ltd.

STORING FERTILIZERS IN CLAMPS IN THE FIELD

Clamping bags of fertilizer in the open is feasible and has several advantages. Early delivery of fertilizers can be taken, thus making sure of supplies and benefiting from the rebate allowed for summer purchasing. The bags of fertilizer can be stored on the fields which it is intended to manure ready for use in the following season: this avoids handling them twice.

The method was first described by a Lincolnshire farmer, Mr. C. W. Parker, in the *Lindsey W.A.E.C. Bulletin* (Winter, 1944) and it has been adopted successfully on several Lincolnshire farms for a number of years. Tests of the method carried out in the 1946-47 and 1947-48 seasons on Mr. C. A. Major's farm at Atterby Carrs were reported in the *Fertiliser and Feeding Stuffs Journal*, June 30, 1948. The procedure used on Mr. Major's farm is as follows:

A 3-feet bed of straw (or straw bales) forms the base of the clamp, and the fertilizer bags are placed flat, side by side, in pyramid fashion, thus:

```
     * *
    * * *
   * * * *
  * * * * *
 * * * * * *
```

With six 1-cwt. bags at the base, each pyramid contains about a ton, and the whole clamp about 18 tons of fertilizer. The pile is covered with a 2-feet layer of straw (or, preferably, straw batts—sheaves of straw bound with twine in a device employing a binder knotting mechanism), topped with dyke cleanings (i.e., waste vegetation—weeds, hedge clearings), the whole being secured with a stack net. No soil is used. All the clamps are sited on well-drained soil but no special precautions are taken regarding drainage.

These notes are based principally on experience with granulated fertilizers (National Compound No. 1, granulated, in 5-ply paper bags) which come out of the clamp in a good friable condition and are easily distributed. Non-granular fertilizers, however, are also clamped regularly and successfully on Mr. C. W. Parker's farm. On this farm additional protection in clamping is afforded by the use of old fertilizer bags trapped along the outer rows of bags between successive layers of the pyramids, so that the used bags hang down and form a sheet over the whole.

GRASS SILAGE FOR WINTER FATTENING OF BULLOCKS

Professor J. Morrison and I. H. Heaney, B.Agr.
Agricultural Research Institute, Hillsborough, Co. Down

THIS article is intended primarily to give the results of a feeding trial with fattening bullocks fed on grass silage at the Agricultural Research Institute, Hillsborough. In view, however, of the great interest now attaching to grass production and conservation, it may be useful in the first place to give a short account of the experience gained in making grass silage at the Institute during the past two years.

In 1947 investigational work was started at the Institute to see how far the production of grass silage could be fitted into general farming practice in Northern Ireland. In planning the programme, various factors were taken into consideration, such as the provision of a simple, yet efficient, silo which could be filled easily, the mechanization as far as possible of the field operations to reduce labour, and the production of grass silage with a minimum loss of food nutrients.

Trench Silos In the light of previous experience with many different types of silo, it was decided to use the trench silo because of its low cost and ease of filling ; also because it was a type which could be recommended for use by the average farmer. Consideration was also given to the site for the silo. During the winter months in Northern Ireland, cattle are usually housed in and around the farmyard. Thus it seemed that the proper place for the silo was near the farmyard, so that the labour involved in emptying the silo and feeding the silage would be reduced to a minimum. Accordingly two trench silos have been made side by side in the stackyard, adjacent to the stock buildings, with one end adjoining the main road and the other end opening out to hard ground. This ensures that the approaches to the silos are always firm and reasonably clean, and filling can proceed without interruption and waste of time. The tractors and other vehicles enter from the main road, and loads are emptied while passing through the silos, thus giving continuous compaction of the herbage during filling.

The capacity of each silo was limited to 50 tons to serve as a demonstration of the type of silo suitable for small farms, but at the same time the construction has been such that the capacity can readily be increased. Moreover, experience has shown that even on large farms it is better to have two or more small silos than one large silo, so that each can be filled and finished off as material—whether arable crop or grass—becomes available during the season.

These silos have aroused considerable interest amongst farmers, and many similar ones have been made throughout Northern Ireland, modified according to differing conditions and circumstances. As a matter of interest, therefore, some of the more important details of dimensions, etc., are given below, with brief remarks on special features and improvements which might be made as a result of experience gained during filling operations.

Length	43 feet
Height of concrete side walls	5 ,,
Width at top	12 ,,
Width at bottom	11 ,,
Capacity of each silo	45–50 tons freshly-cut grass

The bottom of each silo has a light covering of 1½-inch stones blinded with screen dust, and is not more than 2 feet below ground level at the centre. This shallow depth and the ramp at each end allows the silage to be removed easily in hand-operated trolleys or barrows. The height of the concrete side walls could with advantage have been 6 feet for a full 50 tons capacity. Each side wall has a slope 6 inches inwards from top to bottom, which appears to be sufficient for satisfactory consolidation of the herbage during sinking. No reinforcement was used in the side walls, which are perpendicular on the outside, with a thickness of 6 inches at the top and 12 inches at the bottom. Where, however, there is no outside support for the walls, light reinforcement in the concrete would be an advantage. Drain-pipes are placed at intervals through the bottom of the side walls; it is important that there should be free drainage of surplus liquid from the silos, and equally important that outside water should be prevented from running into the silos. No special roof was provided for the silos at the time they were made; this is a debatable point, and the question of a suitable cover for this type of silo under Northern Ireland conditions is still under investigation.

A.I.V. and Molasses In 1947 both silos were filled with grass from a four-year-old ley, the grass being cut by mower, raked into windrows and forked by hand labour into tractor-trailers and horse carts. The A.I.V. method of conservation was adopted for one silo, and the molasses method for the other. During the second half of May last year the two silos were again filled with grass—one with 51 tons 7 cwt. of grass treated with molasses at the rate of 2 gallons per ton, and the other with 47 tons 3 cwt. of untreated grass. The grass used was surplus to requirements at that particular time and was taken from three- and six-year-old leys, which were subsequently grazed for the remainder of the season. The grass was cut by mower and gathered direct from the swath by a green-crop loader into tractor-trailers.

The use of the green-crop loader reduced considerably the labour involved in filling the silos. In 1947 (when loading was done by hand-labour) 7.40 man-hours, 1.11 tractor-hours, and 2.0 horse-hours were needed for cutting, loading and filling each ton, compared with 4.72 man-hours and 1.97 tractor-hours with the use of the green-crop loader in 1948. Experience gained during filling operations last year showed that still further economies in labour could be achieved.

The cost per ton of green grass filled into the silos in 1947 was 23s. 5d. and in 1948, 22s. 5d. These are prime costs including only items of direct expenditure associated with production of the silage. Charges such as rent and overheads are not included. The margin of difference in cost per ton does not appear to reflect the saving in labour in 1948 as shown by the figures already given, because in that year (1) the grass was younger and shorter, and a much greater area had to be cut in order to fill the silos, (2) carting distance to the silos was much greater, and (3) labour costs were higher as a result of a substantial increase in wages.

Experiment with Shorthorn Crosses In the autumn of 1948 it was decided to use the silage made in the trenches to investigate the possibility of fattening bullocks during the winter on a diet consisting largely, or entirely, of grass silage. At the same time it was felt that if the bullocks could be finished satisfactorily, it might point to a means of making winter beef production more economic under existing price levels than when cattle are fed on traditional fattening

2. The seedlings are placed between two boards.

1. Preparing the ground for transplanting.

3. The seedlings are held in position by the boards while they are "lined out".

4. The roots are then covered and soil trodden down before the boards are removed.

'S FORESTS (See pp. 84-6)

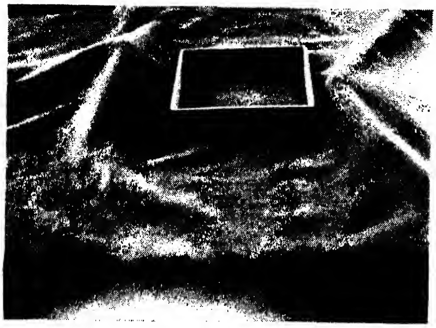
Pine seedlings in a Forestry Commission Nursery at Rendlesham, Suffolk.

Seedbeds sown with beechmast, protected against pigeons by wire netting.

Photos.: J. D. U. Ward.

FROST DAMAGE TO FRUIT (See pp. 86-90)

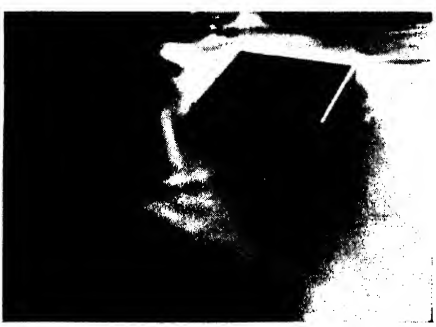
In the accompanying photographs, a small wooden frame represents the walls of a garden on a slope. Air, bubbled through liquid air, is led to the top of the slope, and on account of its high density it flows down the slope, forming a dense fog when it mixes with the surrounding air. The fog thus shows where the cold air flows.



1. Model of garden walls on a slope.

2. Cold air flowing downhill cascades over the top wall to fill the whole garden.

3. If the garden is protected by a diagonally-running wall, hedge or hessian screen, it is kept completely clear of cold air.



4. Walls set at an angle of about 45 degrees to line of greatest slope deviate most of the cold air, so that little of it enters the garden.

Photos.: *Professor D. Brunt.*

rations, or even on the foods which the average farmer can at present provide. For the purpose of the experiment ten bullocks were purchased at the beginning of December. They were mainly Shorthorn crosses of good type and in forward store condition. On December 9 they were weighed, divided at random into two equal groups, and housed in adjoining loose boxes. The average weight of those in Group 1 (to be fed entirely on grass silage) was 10 cwt. 0 qr. 8 lb., and in Group 2 (to be fed on grass silage supplemented with a small amount of crushed oats) 10 cwt. 0 qr. 4 lb.

During a preliminary period extending to January 3, 1949, both groups received only molassed grass silage. The bullocks took more readily to the silage than was anticipated, and in the first eleven days the daily quantity was stepped up from about 45 lb. per head to 112 lb. Although they were bedded with oat straw, the bullocks did not seem inclined to eat it, even from the very beginning. Water was laid on to each pen but was not really necessary as the bullocks seldom drank any. The silage had an obvious laxative effect, but apart from making all the bullocks scour, in rather the same way as flush grass in spring, it did not seem to upset them in any way. During the preliminary period, which was longer than was at first intended, the amount of silage consumed by the ten bullocks was 237 cwt. 2 qr. 7 lb.

The actual experimental period began on January 3, when the first fortnightly weighing of the bullocks was made. From this date Group 1 was fed to capacity on silage only, consuming approximately 126 lb. per head daily. Group 2 received a daily allowance of 4 lb. crushed oats per head in addition to a little over 100 lb. silage. The experimental period lasted ten weeks. Molassed silage was fed to both groups for the first seven weeks (when the first silo was empty), and untreated silage from the second silo for the remaining three weeks. A slight temporary reduction in silage consumption was noted for a few days after changing to the untreated silage. However, the bullocks soon recovered their appetite and seemed to find this silage equally palatable once they became accustomed to what appeared to be slight differences in flavour and odour.

Twenty-one representative samples of the silage fed to the bullocks were taken from various points throughout the silos and analyzed by the Chemical Research Division of the Ministry of Agriculture for Northern Ireland, with the following average results :

Type of Silage	Starch Equivalent(1)	Crude Digestible Protein(2)	Dry Matter	*p*H
	per cent	*per cent*	*per cent*	
Molassed	12.0	1.87	20.9	3.96
Untreated	11.8	1.81	20.5	3.88

(1) Calculated from average starch equivalent value of 57.5 for the dry matter of grass silages.*
(2) Calculated from regression equation for grass silages.*

Both silages were described as : "acid to slightly fruity, of excellent quality as judged by the *p*H values". The average protein content (on dry matter basis) was 13.87 per cent.

There seems little doubt that good silage with comparatively little loss can be made in a trench silo, as the following figures show for the molassed silage taken from the silo which was completely emptied :

Weight of grass put in	51 tons 7 cwt.
Weight of good, edible silage taken out	46 ,, 1 ,,

* WATSON, S. J. *The Science and Practice of Conservation* (1939).

Table 1
Food Consumption

Group	Date of Weighing	Total Weight of Pen	During previous Two Weeks: Silage consumed	Average consumption of silage per head per day	Oats consumed	Estimated S.E. intake	Average Consumption of S.E. per lb. Liveweight Increase
		lb.	lb.	lb.	lb.	lb.	lb.
Group 1 (Silage only)	1949 January 3	5,866	—	—	—	—	5.44
	,, 17	6,279	8,484	121.5	—	1,018.1	
	,, 31	6,482	8,925	127.5	—	1,071.0	
	February 14	6,650	8,862	126.6	—	1,063.4	
	,, 28	6,825	8,715	124.5	—	1,037.2	
	March 14	6,832	9,065	129.5	—	1,069.7	
	Totals for whole period	—	44,051	Average 125.9	—	5,259.4	
Group 2 (Silage and oats)	January 3	5,845	—	—	—	—	6.38
	,, 17	6,125	6,811	97.3	280	985.3	
	,, 31	6,321	7,028	100.4	280	1,011.4	
	February 14	6,482	7,854	112.2	280	1,110.5	
	,, 28	6,664	7,805	111.5	280	1,096.9	
	March 14	6,678	7,980	114.0	280	1,109.6	
	Totals for whole period	—	37,478	Average 107.1	1,400	5,313.7	

Table 2
Liveweight Gains

Group	Period	Date of Weighing	Average Weight per Bullock: cwt.	qr.	lb.	Period since Previous Weighing	Average gain per head per day: Since previous weighing	During experimental period
		1948–49	cwt.	qr.	lb.	days	lb.	lb.
Group 1 (Silage only)	Preliminary period	December 9	10	0	8	—	—	—
		January 3	10	1	25	25	1.8	—
	Experimental period	January 17	11	0	24	14	5.9	2.8
		,, 31	11	2	8	14	2.9	
		February 14	11	3	14	14	2.4	
		,, 28	12	0	21	14	2.5	
		March 14	12	0	22	14	0.1	
Group 2 (Silage and oats)	Preliminary period	December 9	10	0	4	—	—	—
		January 3	10	1	21	25	1.8	—
	Experimental period	January 17	10	3	21	14	4.0	2.4
		,, 31	11	1	4	14	2.8	
		February 14	11	2	8	14	2.3	
		,, 28	11	3	17	14	2.6	
		March 14	11	3	20	14	0.2	

This silo was sealed and weighted with soil to an average depth of 6 inches. The weight of actual waste material was approximately 1 ton. This occurred mostly at the extreme ends of the silo, where it was impossible for the tractor wheels to consolidate the material close to the walls.

Table 1 shows the quantities of food consumed by the bullocks during the experimental period, together with the estimated intake of starch equivalent. Table 2 gives the liveweight gains.

In the estimations in Table 1 the S.E. of oats was assumed to be 60. The theoretical requirement of S.E. per lb. liveweight increase by a bullock weighing 11 cwt. and gaining 3 lb. per day is 5.47 lb. Hence the average consumption of S.E. per lb. liveweight increase by Group 1 (5.44 lb.) is just what would be expected. On the other hand, the consumption of Group 2 (6.38 lb.) was higher than anticipated, especially when it is also considered that the average daily liveweight gain of these bullocks over the whole period (Table 2) was considerably less than in Group 1.

From these results it would appear that in this particular experiment the feeding of oats in addition to a large quantity of silage was unnecessary and, in fact, a waste of starch equivalent. The two groups of animals are so small that it would be unwise to draw too definite a conclusion, but the figures do show that very satisfactory results can be obtained on a diet of silage alone.

Differences in the contents of the digestive tract at successive weighings are bound to influence individual gains to some extent, even though the weighings were as far as possible carried out at the same time of day on each occasion. Thus the high rate of gain in weight during the two weeks ending January 7 must to some extent be accounted for in this way. However, the almost entire lack of any gain during the last two-week period ended March 14 cannot altogether be explained in this way. It would seem that the bullocks, which were all very even as regards size and condition, were really "finished" at the end of February, and thereafter were doing little more than maintaining weight. Indeed the final stages of the trial were actually wasteful of food. This was borne out by the results obtained when the animals were slaughtered, and by the butchers' opinions of the carcasses.

The bullocks were disposed of through the normal grading channels. They were all fasted for twenty-four hours and weighed immediately before slaughter, after which the carcass weights were obtained. Particulars of the grading and killing-out percentages were as follows:

Group	Number of Bullocks in each Grade			Average Killing-out Percentage
	A+	Special	Super-Special	
1	–	3	2	60.0
2	1	1	3	60.4

Financial Aspect When the carcasses were hanging in the abattoir it was the opinion of two prominent butchers that they were of excellent quality with no discoloration in the fat. There was no noticeable difference in carcass quality or in type of fat between the two groups.

Reports received from the butchers to whom the carcasses were allocated confirmed the opinions given at the abattoir. The quality and flavour of the meat were excellent, the only criticism being that the proportion of fat was rather high; in present circumstances this made it more difficult for the butchers to dispose of the carcasses to the best advantage in their allocation of rations.

It is important that the financial aspect of a trial such as this should be considered, and the costs and returns are given below. No credit has been allowed for the manure, 38 tons of which were weighed out of the loose boxes, and no charge has been made for straw used as litter or for the labour of carting away the manure. The results of this experiment, whilst in no way conclusive, by reason of the small number of cattle used, do indicate the possibilities of fattening cattle economically in winter where silage is available for the purpose.

	£	s.	d.	£	s.	d.
Selling price (10 bullocks)	585	13	0			
Purchase price ,,	462	10	0			
Gross margin				123	3	0
DIRECT COSTS						
Labour	9	0	0			
Silage (48 tons @ 25s. per ton)	60	0	0			
Oats (12½ cwt. @ 20s. per cwt.)	12	10	0	81	10	0
Surplus over direct costs				41	13	0

The returns obtained from the bullocks would have shown a higher margin had they been disposed of earlier, and it is a pointer as to what might be done with cattle in less forward condition at the commencement of feeding. It does not appear to be necessary to supplement grass silage with oats when large quantities of palatable silage are fed. Indeed, in this particular experiment it was uneconomic to do so. On the other hand, there may not be sufficient silage available on many farms to form a complete fattening ration, and a reasonable allowance of home-grown grains would probably be justified, provided silage comprises the major portion of the ration.

It is, of course, the aim of most farmers to produce high protein silage for milk production, but in practice a lot of low-to-medium protein silage would often be made and could be used economically for feeding to young stock and fattening cattle. Moreover, with higher costs of purchased foods, the use of silage, whether from special crop mixtures or from grass, has assumed increased importance, and there is little doubt that in many districts the output from our grasslands for direct consumption and for conservation could be greatly increased.

YARDED BEEF PRODUCTION

J. A. STODART
Kingston, North Berwick

MY farm is run on a seven-course cropping system, with about 60 acres of each crop, including only one year's grass for hay. Cropping with the sole intention of growing enough of each commodity to suit the cattle needs between 25 and 30 acres of roots: we use about 12 acres of purple-top swedes between October and the New Year, another 12 acres of long-keeping green-tops from the New Year until mid-April, and 6 acres of mangolds from then onwards. About 30 acres of oats are required to give

the necessary straw for feeding in the early stages of fattening and 20 acres of hay for the finishing process. It is quite impossible to assess with any accuracy the amount of barley straw actually needed for bedding, as we use so much straw off the potato pits for this job, thus getting a double use out of it. All this will do 90 beasts, which in turn will make just about 10 tons of dung each—enough to put 15 tons an acre on 60 acres of land for potatoes.

As a result of this system of feeding and management, we have been able to average a grading record of over 90 per cent of the beasts in the Super-Special grade. The balance consists of animals that are either too heavy to make the very top grade or have just not done well—and it is inevitable that out of a hundred beasts you will get one or two bad doers. Even this grading record does not, alas, make cattle feeding a very profitable concern. I doubt very much if any profit at all can be made at today's costs unless a feeder can get *at least* a £45 margin on each beast. Naturally it depends on the value placed on the dung that the cattle leave behind them; if you care to inflate the value of that, you coax yourself into thinking your cattle have done very well by you. Of course, there must be a limit to what dung is worth; but it is generally agreed in the arable districts of Scotland that if you can turn over your cattle so that they cover your costs, and do no more than give you the dung for the cost of handling it, you are doing as well as you have any right to expect. That really sums up our attitude to dung and the consequent importance which we attach to the production of really good Scotch beef.

Those farmers from other parts of Scotland, and perhaps particularly those south of the Border, whom we are always delighted to welcome to East Lothian, will agree with me when I say that the potato crop is the backbone of this great arable farming county, and that the dung-midden is the nerve centre of it all. At a recent debate staged by the local agricultural discussion society, two well-known beef producers (one of them just home from a tour of the Argentine) joined battle with two eminent protagonists of the new cult of keeping dairy cows in yards, instead of fattening beasts for beef. Significantly enough, a large audience voted dead level on this issue, and it was left to the chairman to give his casting vote. This he did in favour of beef.

It is no part of my task to enter the lists on one side or the other. I have a profound respect for the dairyman, who puts in his seven-day week, often, I fear, unappreciated by the townsman, who takes it for granted that somebody will put his milk on the doorstep on Sunday morning while he himself enjoys a long lie. All the same, I will say that I would much rather have an extra sixpennyworth of good English or Scotch (no, Scotch or English!) beef every week than another pint of milk.

Experience with Open Yards In the fifteen years during which I have been farming this 428-acre arable farm (I took it over when I was 17) I have definitely come to the conclusion that, to keep up the fertility of a farm, compost and artificials are inadequate —I take my stand firmly by a lot of dung and some artificials as well. The farm has been worked pretty hard since 1939: there have never been less than 413 acres under the plough, a seven-course rotation with one year's grass providing the hay crop. That it has stood up to it and is still producing 7-quarter (56 bushel) crops of wheat and barley, 10-quarter (80 bushel) crops of oats, and 9½ tons per acre of King Edward potatoes, says quite a lot for it.

I feed between 80 and 100 bullocks in the yards every winter, each yard holding a dozen beasts comfortably. Before the war, of course, when in our ignorance farms of this kind got through scores of tons of oilcake every year, we managed to turn out two relays of cattle. Those put in in October were marketed in January to make room for another lot. Today that is impossible, and so we make no effort to hurry the beasts, as we want just as much straw trodden as we can get. Having virtually no grass, I buy all the cattle during October and November, and grade them throughout April, May and June.

As we have a lot of straw to tread—not only from the machine at threshing time, but off the potato clamps throughout the winter—I have found it most productive of muck to buy a strong store, weighing around 10½ cwt., which will ultimately grade at 12½–13 cwt. This year I have just about half-and-half of home-breds and Irish : the former (black Angus crosses, cross Shorthorn-Highlanders and blue-greys grouped accordingly) came in from grass in better condition than I think I have ever seen them. The Irish bullocks, much more gaunt of frame and lacking all that character which well-bred home cattle possess, were much cheaper to buy and will, I am fairly confident, go to the graders ½ cwt. heavier than the home-breds.

On the other hand, for giving that general feeling of satisfaction at owning good quality stock—and the farmer who does not know and value that feeling is a poor fellow—the home-breds score over the Irish. In my county the Shorthorn-Highland cross bullock has made a minor invasion during the last three or four years ; so well have these cattle done for those who have fattened them that the bidding for them each October has become increasingly keener. Certainly they were the dearest cattle I bought last autumn.

I am a great believer in the open yard with a good shelter for the beasts to lie under if they want to. I well recollect an authority (at least, he had written a book!) assuring me that cattle fattened far quicker if they were exposed in an open yard, with no shelter overhead from the full rigours of a northern winter. Frankly I can't credit it. Nor am I keen on the roofed-in yard, although I do admit that the value of the dung, undiluted by rain, is probably higher. Against that, I submit that beasts in a covered yard get no benefit out of the lengthening days during spring when, in the open, the very considerable benefit of the sunshine can be derived for nothing. I am a disciple of the middle way ; an open yard with a big enough shelter attached to house all the beasts at night seems to me to be the soundest course.

Feeding Hitherto, East Lothian has been a great turnip countryside. Certainly the most noticeable aspect I find about East Anglia, or indeed about English farming generally, is the absence of roots. It has been the general habit to feed about 80 lb. of swede turnips to each bullock every day—a diet which has been spurned by the scientists on the grounds that the average swede contains about 90 per cent of water. The answer is, of course, that it must be first-class water, because I have tried feeding beasts on a balanced ration in which there were only 40 lb. of swedes, and I can vouch for the fact that the results were not nearly so good. Shortage of labour has compelled many farmers to go in for feeding turnips whole, and they tend to claim that the beasts do just as well. Personally, I cannot think that there is much difference between the effect of a whole turnip on a bullock and a thoroughly unattractively served plate of meat on me. Anyway, we continue to cut the turnips here, and the arrival of electric power a year ago has made the job fairly easy.

There is, however, little doubt that the days of turnip-growing are numbered; labour difficulties for singling and topping, and the lack of a machine for the job, are reducing the root acreage in East Lothian very quickly. Silage is taking its place, and a lot of beans and oats have been sown this spring. Kale, too, is attracting a fair amount of attention; those who tried their hand at kale silage last year are fairly pleased with the result, and there will probably be more going in for it this autumn. Tests are now being made under the direction of the local agricultural college with a view to determining whether kale silage is as good for beef production as it is known to be for milk.

The cattle here get turnips and oat straw from October until the beginning of February. The oat crop is, of course, Scotland's main cereal, as so many of our administrators tend to forget. Not only do we like our porridge, but we take good care to cut the crop before it is dead ripe, and preferably when there is plenty of sap in the straw. Oat straw cut on the green side has every bit as good feeding value as middling hay. From February onwards, hay takes the place of straw, each beast getting about 14 lb. a day. At the same time we add a ration of any available feedingstuffs. There is always a good supply of light oats and barley to put through the bruiser, and there has always been a modest helping of protein from the local Committee. Until this year we got a good supply of beet pulp, which was immensely useful. Once direction of cropping ceases, however, not even the usefulness of beet tops and pulp will induce me to grow sugar beet on a farm which is manifestly unsuitable for it—a fact which the seven-year average of only 8 tons an acre fully bears out. However, in spite of having no pulp this year, we have not done too badly, as there seem to have been a few more coupons available.

SIR THOMAS BAXTER

A career of outstanding service to agriculture ends on June 10, when Sir Thomas Baxter, now 71 years of age, relinquishes the Chairmanship of the Milk Marketing Board after sixteen years' indefatigable service in the cause of organized milk marketing. Sir Thomas became the Board's first chairman with its inception in 1933, and now, looking back on the years between, Sir Thomas may justifiably feel proud of his considerable contribution to the extensive development of the services organized by the Board today throughout England and Wales.

CLAY MARLING: SOME HISTORICAL NOTES

A. C. MIDDLETON, B.Sc.(Agric.), Q.A.L.A.S.
Surrey Agricultural Executive Committee

This is the first of two articles on marling. The second article will appear in next month's issue and will deal with experiments recently carried out in the East Riding of Yorkshire.

IN the early days of British agriculture, dung, marl, burnt turf, burnt lime, and (later) bones were the chief soil improvers; of these, marl was one of the commonest. By virtue of its clay content, its main use was to stiffen sandy soils, to prevent "blowing" and to bind peaty soils, though various sorts of marl had different uses, as will be seen later.

In about the year 1516, George Owen[1] writes in his *History of Pembrokeshire*: "The next chiefest kind of mending of the land is the claye marle . . . and is of nature fat, tough and clammy. The common people are of opinion that this marle is the fatness of the earthe, gathered together at Noah's flood; which is verie like to be true . . . There is an ancient memorial, by continuance of report, that the use of marle in Kemmes was first found out by one Cole, a Frenchman, who was said to have come into this countrey with Martin de la Tours, the conqueror of Kemmes."*

In Volume I of *British Husbandry*, published in 1834, we read: "There are noted leases on record granted in the reigns of Edward I and II which compel the tenants to make use of it (marl); the Charta Forestae passed in 1225 mentions the right of sinking marl pits; and Daines Barrington gives a quotation from Pliny in which he mentions a substance used in Britain and France as a manure called marga, which he says is a mistake for marla. And in the Statutum Wallice 12 Ed. I, the Sherriff and Coroner are directed to enquire as to the marl pits which are in public roads, showing its then common use."

Marls Used "The term marl is employed in Cheshire," says Holland[2] in 1808, "in a most comprehensive sense including a variety of substances . . . the most common varieties are distinguished by the appellations of clay marl, slate marl and stone marl; the first . . . is perhaps the most beneficial." Among early writings the term indeed covered a diversity of substances, even to sand marl for lightening heavy soils, and in some cases marls and clay had chapters to themselves, and although some importance was attached to the lime content, the clay content of both marl and clay came to be recognized as their chief virtue. Perhaps the writer[3] of the following foresaw the existence of Provincial Advisory Chemists and their methods of mechanical soil analysis when he wrote:

March, 1795—I sent four fragments of the marl from the same pit . . . to Mr. Renwick, Chymist, in Liverpool, to be analysed.

	1	2	3	4
Flinty sand, grains	$40\frac{1}{2}$	$40\frac{1}{2}$	34	$32\frac{7}{10}$
Clay and silicaceous earth, grains ..	$39\frac{1}{2}$	39	44	$47\frac{3}{10}$
Calx, grains	$19\frac{1}{2}$	$20\frac{1}{2}$	22	20
Lost grains	$\frac{1}{2}$	—	—	—

These claying or marling materials in fact embraced the red Keuper marls used in Staffordshire, Cheshire and East Yorkshire, the marls of limestone and chalk origin used in eastern England, Gault clay used in the eastern counties, brick earths in the East Midlands and Kent, and a wide variety of other clays found elsewhere.

* In the twelfth century.

Methods of Marling Most marling was done by hand, and in 1795 John Holt([3]) of Walton, near Liverpool, writes : "Getting and filling marl is a very laborious work . . . and can only be effected by young men in their prime, cheared by the company of their fellow labourers and frequent refreshments." A further reference to the thirstiness of the work is made in some Staffordshire figures([4]) published in 1796, in which, of a total cost of £3 15s. per acre, carriage amounted to £2 10s. per acre, while labour, spreading and beer accounted for the rest.

Where the clay closely underlay the top soil more or less evenly, as in the fen country, the practice was usually to dig trenches 3–4 feet wide and 12–20 feet long, the top soil being thrown to the ends or to one side, and the clay being thrown to the sides. The lines of trenches, about 11 yards apart, were then backfilled and the clay scattered over the land. In Lancashire, Cheshire, Hampshire, East Yorkshire, and elsewhere, however, the marl was dug from pits, filled into horse-drawn carts, and shot out into regularly spaced heaps which were later spread by hand, while in 1841, William Linton([5]) of Sherriff Hutton, near York, reduced his costs from £5 9s. 3d. to £5 2s. 3d. per acre by constructing a horse-driven windlass to draw the carts out of the pits. He also advises siting the pit to cut across a fence and so make a future permanent watering point for two fields. To this day, Ordnance Survey maps show that nearly every field in his neighbourhood had its own marl pit.

In 1856 Joshua Trimmer([6]) compares the costs of using railway wagons as against horses and carts for transporting marl in the New Forest, while James Garnett([7]) writes in 1849 of a movable light railway being used at Chat Moss in Lancashire, a system which was also used round about the same time for marling the light Bunter sands of Delamere Forest in Cheshire. Again, Henry Holland, in 1795, refers to burning the marl in kilns and clamps, bruising it into a powder and sowing by hand as a top dressing. Most farmers used their own farm labour and horses and carts, but Joshua Trimmer allows for contractor's profit, and in 1834 we hear that "where marling is regularly carried on throughout the year, it is generally managed by persons who make it their sole business".

Marling Seasons Early advice on marling is mentioned by John Davies in his South Wales Report of 1816. He quotes a translation of the sixteenth century Cattw Cymraeg's *Advice from a Father to a Son*: "Dig thy marl when thou hast completed thy spring ploughing; expose it to heat; and when rain comes stir the heaps, turning the roasted marl inwards, and the raw marl outwards; and this turning will cause it to crumble and effloresce, and collect fatness; and when winter and frost arrive, stir it again, that the weather may pulverise it; and when spreadable, lay it upon thy land, and plough it in."

Again quoting George Owen in 1516: "They use the marl thus: it is digged and cast out of the pitte, carried to the lande, and there cast either upon the fallow or lay ground, unplowed, and thus in the somer-tyme . . . or after harvest and at all tymes of the year fit for casting of it, if the weather be fine, where it lyeth so on the lande all the somer and winter, the rain making it to melt and run like molten ledd all over the face of the earth."

The general idea is expressed by John Holt in 1785: "The marl should partake both of one summer's sun and one winter's frost at least" and "The summer is the best season for laying marl upon the land, sometimes immediately after a crop of hay". And in 1842 Charles Burness([8]) writes of marling on one of the sandy Woburn farms of the Duke of Bedford: "Put the clay on

the clover leys as early as the crop is off, and then get it broken in pieces as much as possible before it is ploughed in for wheat." The preference for marling on seeds instead of on fallows generally arose from the easier carting and the desire to avoid the loss of a root crop, though winter marling on land for roots sometimes provided work for men who would otherwise have had to go to the parish for relief.

Amounts Used and Results Obtained There is great variation in the size of dressing, though two main tendencies emerge. First, the use of comparatively small dressings of 40–60 cu. yards per acre, particularly on peat and fen soils, which would not stand excessive carting by iron-rimmed wheels, and secondly, the use of larger dressings of 120–300 cu. yards per acre, with an average of about 150 cubic yards.

Of the smaller dressings, Arthur Young's *Lincolnshire* (1808 edition) mentions: "Mr. Cracroft of West Keal has done most of the sandy lands on his farm. He lays 40 loads an acre. Before, the turnips ran to fingers and toes and were rarely worth more than 10s. to 12s. per acre, but now that distemper disappears as soon as the marl gets mixed up with the soil and the crops are worth £3 to £4 per acre. Barley used to produce about 2 qrs. an acre, now 5 or 6." The practice was similar in Hampshire, and Charles Vancouver(9) writes in 1810: "The quantity most commonly applied is about 45 tons of marl. Its . . . effect is to demonstrate the most beneficial consequence for a period of 25–30 years."

Of the larger dressings, W. Pitt says of Staffordshire, in 1796: "The quantity laid upon an acre is usually . . . about 128 cu. yards per acre," and in Cheshire (1808) Holland says: "On light or sandy soils 2 cu. roods each containing 64 solid yards, for a statute acre". In Yorkshire, Linton says 100–200 cu. yards per acre according to how light the land is, and just sufficient to grow wheat after seeds. The average was 150 cu. yards, though 120 years earlier (1721) J. Mortimer, in his *Whole Art of Husbandry*, describes the same area and says that 100 loads per acre is usual on these sandy soils. He goes on to say that the initial effect is not very great but that after the first year or so the effect lasts forty or fifty years, and that oats, barley and pease could be grown where only rye would grow before.

J. Worlidge's *Systemae Agriculturae: the Mystery of Husbandry Discovered* is graced by a delightful introduction in verse. The third edition, published in 1681, also describes the various sorts of marl and clay for different soils and makes a good point. "It is very necessary in marling lands to find out the true proportion, how much on every acre, that you add neither too much, nor too little. It's better to erre by laying on too little than too much, because you may add more at pleasure, but you cannot take away. This marle will keep the land whereon it is laid, in some places ten or fifteen and in some places thirty years, in heart . . . it also affordeth not its virtue or strength in the first year, so much as in the subsequent years." However, the size of dressings tended to fall by half, we are told in 1834, and almost the same benefit was achieved though not of so lasting a nature; thus a farmer could marl double the acreage at the same cost and reap all the probable benefit within the term of a moderate lease. There was no Agricultural Holdings Act in those days, so we are not surprised to read: "Tenants should be cautious . . . unless backed either by the security of a long lease, or by their entire confidence in their landlord."

As to the financial benefits derived from heavier crop yields there are many excellent costings, though too discursive to be quoted here. Two can, however, be summarized. Linton(8) in 1841 shows that the value of produce

over a four-course rotation on sandy land near York was £14 7s. per acre; after marling at 150 cu. yards the value of the produce was £24 16s. 6d. per acre if the marling was done on the seeds course, and £22 15s. if done on fallow. These figures are borne out by some costings made in the same year on claying done for Lord Harrowby at Digby, Lincs.[5] This, however, was trenching, and 15 bushels of bones were applied the year before. The value of the produce was raised from £12 9s. to £20 3s. 6d. per acre for the three-year period following, and the effect lasted for at least 15 years. Arthur Young notes that the rental value of other Lincolnshire land was increased from 4s. or 5s. per acre to 14s. or 20s.

Except for some extreme instances of 300-ton dressings on very poor land in Lancashire and other parts, marling generally paid for itself in bigger crop yields in the first 2–3 years, quite apart from reducing both the incidence of finger and toe and the growth of annual weeds on light and (probably) acid soils. Neither have 432 years disproved these words of George Owen: "The marle . . . causeth the grounde, be it ever so barren before, to bring forth fine grasse, full of the hearbe call trifolium, both white and redd, soe that in the somer-tyme the lande will be covered with these flowers and will yeald a most pleasant and fragrant odour proceeding from these sweete flowers". He goes on to say "Marle long sithence was much used about a hundred and sixty years past, as appeareth by land marled . . . and is found, by proofe, to continue good to bring corne and grasse for a hundred and sixty yeares together."

Cost of Marling An abundance of cheap labour was, of course, an inducement to marl, though there was some raising of eyebrows at the royalties charged. For instance, Mr. Cracroft in Lincolnshire paid 1s. a load, and we find Joshua Trimmer arguing that if the Crown would reduce its charge for New Forest marl from 6d. to 3d. per cu. yard, more would be used. Vancouver says that where marl was taken from Commons, some Lords of Manors charged 5s. per acre marled and others 2d. per four-horse tumbril. There are many excellent accounts of the cost of marling. In Cheshire 150 years ago the cost was as follows:

Stripping of 3 feet of overburden	12s. per cu. rood of 64 yards
Digging and filling marl	12s. ,, rood
Leading, up to 150 yards	20s. ,, ,, ,,
Spreading by hand	4s. ,, ,, ,,

or about £5 per statute acre (1 Cheshire acre is equivalent to 2 statute acres and 18½ perches).

In 1810[6], we have costs for hauls of up to one mile from pit to field, at 45 tons per acre only:

	£	s.	d.	£	s.	d.
2 men and 1 filler at 2s. 6d. per day each ..		7	6			
3 carts or tumbrils and 9 horses at 4s. per horse per day including wear and tear ..	1	16	0			
1 driver at 2s. per day		2	0			
Spreading and pulverising at 2s. 6d. per score loads		1	9			
Total for half an acre	2	7	3			
Total for one acre	..		..	4	14	6
Add fee to the Lord of the Manor	..		..		4	6
Add the expense of uncovering the marl ..	..		..			9
The whole cost of marling at this distance per acre				£4	19	9

Just over 100 years ago, William Linton[5] costed his marling as follows, on a slightly longer haul at 150 cu. yards per acre:

	£	s.	d.
Digging and spreading 150 yards at 4½d. per yard ..	2	16	3
Four horses four days at 2s. 6d. each per day	2	0	0
Driver four days at 2s. 6d. per day		10	0
Other expenses (wear and tear)		3	0
Total expenses for marling one acre	£5	9	3

Conclusion Thus was marling done in days gone by, when labour was cheap and plentiful at 2s. 6d. a day and less. We should conclude perhaps by posing some questions in the light of present-day circumstances. For instance:

(a) What is the present cost of marling using modern machinery, and does it pay at present crop prices?

(b) Is the use of modern movable oil-fired driers and of lime spreaders or combine drills too expensive these days?

(c) What are the best techniques for marling sands and for claying fens?

(d) It is better to apply a single large dressing, or periodically to apply smaller ones?

(e) What are the optimum dressings for different types of soil?

(f) Can the small farmer marl or must he rely upon contractors?

(g) Can the present-day public works contractors, with their modern earth-moving equipment, perform marling for farmers at an economical price?

It is hoped that the experimental marling recently completed for the Ministry in the East Riding of Yorkshire will help to answer some of these questions.

References

1. See also Davies. *South Wales Report* (1816).
2. Holland, H. *The Agriculture of Cheshire* (1808)
3. Holt, J *General View of the Agriculture of the County of Lancaster* (1795).
4. Pitt, W. *General View of the Agriculture of the County of Stafford* (1796).
5. *Jour. R.A.S.E.* (1841), **2**.
6. *Jour. R.A.S.E.* (1856), **16**.
7. *Jour. R.A.S.E.* (1849), **10**.
8. *Jour. R.A.S.E.* (1842), **3**.
9. Vancouver, C. *Hampshire Report* (1810).

THE NURSERIES OF TOMORROW'S FORESTS

J. D. U. Ward

Lamborough Hill, Abingdon, Berks

In the forest nurseries of Britain another sowing season nears its end. In normal years, March and April are the chief months for sowing tree seeds: March for Douglas fir and native hardwoods, such as oak, beech and ash, and April for most others. Except in certain beechwoods there is relatively little natural regeneration of trees in Britain (rabbits are too numerous), and nearly all afforestation and reafforestation is, therefore, dependent on trees raised in nurseries. At the present time the State's

forest nursery stocks probably comprise more than 335 million seedling trees and nearly 115 million transplants, but this is no excessive number for the great task ahead, since foresters have not only to make good the losses caused by heavy fellings during two wars but also to expand and improve old woodlands which have been neglected ever since oak ceased to be the chief material used in shipbuilding.

The two first requirements of a nursery site are good, well-drained soil and a position sheltered, as far as possible, from both winds and frosts. In other respects there are many differences between nurseries ; some cover less than 3 acres and are set in the middle of an old forest, while others are wide and open. Britain's largest forest nursery is near Cardiff. It covers more than 100 acres, employs a staff of over 50 (many of them girls), and normally has a stock of over 50 million young trees—seedlings and transplants.

Seed Much of the seed sown in the nurseries, e.g., most of the oak, ash and beech seed, and a fair quantity of Scots pine and larch seed, is collected in Britain. But some seed comes from Europe : even during the war a large quantity of larch seed and some beech seed was collected for us in German-occupied areas, and the Forestry Commission sent an officer out to Corsica, when the war was by no means over in that theatre, to buy the best of one year's crop of Corsican pine seed.

As Britain is now introducing large numbers of North American trees into her forests,* she naturally obtains quantities of seed from Canada and the U.S.A.—especially from the Far West. After the war she shared with France and Belgium an American gift of 12 million Douglas fir seeds, but even before the war she would buy such single "parcels" as 2,000 lb. of Sitka spruce seed (about 400 million individual seeds).

Effect of Climate Incidentally, western Britain's relatively mild, moist climate is especially congenial to certain of the largest and most valuable species of timber trees growing on America's Pacific coast. Such trees as Douglas fir and Sitka spruce make much better growth in Britain than anywhere on the mainland of Europe. It may be added that, in favourable sites, Britain has also surpassed Continental records of timber yields in certain European species, such as the Scots and Corsican pines. Indeed, with British forests care is necessary lest, by reason of too rapid growth, inferior timber is produced.

Because of the climatic differences between the mainland and this island, much European experience is of limited value in Britain, and, with the revival of British forestry, foresters have had to begin with quite elementary experiments. The point may aptly be illustrated by reference to tree seeds. Foresters found that Sitka spruce grown from seed collected in the Queen Charlotte Islands, off the coast of British Columbia, is less susceptible to certain kinds of frost damage than Sitka spruce grown from Californian seed. Again, Douglas fir seed from some elevations gives better results than seed from other elevations.

Research Although Britain may often be unable to benefit directly from European experience, her foresters do derive from the international exchange of seeds the direct benefit of certain errors—errors which emphasize the importance of selecting forest tree seed with the greatest care. There is a classic Swedish example : pine seed was imported from Germany, but the dealers in Darmstadt had obtained their seed from

* WARD, J. D. U. Britain's North American Trees. *Agriculture* (1948), 55, 212.

Belgian, French and Hungarian forests, as well as from German trees. The trees raised in Sweden from this heterogeneous seed grew rapidly at first, to the joy and pride of the foresters, but disappointment followed when many of the trees proved to be of bad types, with crooked stems, thin crowns, heavy branches, and other serious faults.

Continental foresters (especially in Austria and Switzerland) have since proved that some good and bad qualities in certain species are hereditary, and in these times both Continental and British foresters are cautious about the provenance of their tree seeds. There is even now in progress a large-scale international experiment (in which British forest nurseries are co-operating) to test the qualities of different "races" of European larch, i.e., larch grown from seed collected at various elevations and from various countries. Moreover, much research is being carried out constantly in British forest nurseries: current research and experiments include the values of various weed-killers, the qualities of various fertilizers, techniques of sowing, cultivating, watering and sheltering, the characters of new hybrids, and the relationship between fungi and trees.

Methods of Sowing In those nurseries which are concerned less with research than with supplying the stock of trees for afforestation and reafforestation, tree seeds may be sown either broadcast or in the drills more usually favoured on the Continent. The larger seeds, such as oak (whose acorns weigh about 120 to the lb.—an interesting contrast to the Sitka spruce's 200,000 seeds to the lb.) are normally broadcast. The smaller kinds of seeds are usually covered after sowing with almost white "sharp sand," which gives better results in germination.

During their first winter, when the seedlings are between six and ten months old, most of them are transplanted to new positions; this work is done by hand, normally with the help of transplanting boards. The young trees, now advanced from "seedlings" into "transplants," remain in their new lines for one or two years. Then, during the second winter, they are transferred to their destined places in the forests, where they can grow into timber for tomorrow.

FROST DAMAGE TO FRUIT

THE PRESENT POSITION OF RESEARCH IN ENGLAND

W. S. Rogers, M.A., D.Sc.
East Malling Research Station

DAMAGE to fruit blossom by spring frosts, causing partial or complete loss of crop, is one of the most serious problems of the fruit industry. It affects not only the grower and the consumer, but also all the auxiliary trades; moreover, its effect is often felt beyond the actual year of damage, for it may set large areas of trees into biennial bearing and start a sequence of scarcity and glut which may take years to smooth out.

In England, research work is being co-ordinated by the Agricultural Research Council, at whose request this note was prepared, and, in response to a keen demand from the fruit-growing industry, it has been intensified in recent years. Before describing some of the latest lines of research, it is worth noting some progress that has already been made, for observation of new plantations suggests that several important points, now well established, are still not always fully appreciated.

Some Established Points The movement of cold air during radiation frosts (the commonest type) is now fairly well understood, thanks to the detailed researches of Cornford (1) and the keen observations and writings of Bush (2,3). On calm, clear nights all objects, including vegetation, lose heat by radiation to the sky. The air in contact with them is chilled, becomes denser and so tends to move downhill, forming the so-called katabatic wind. This cold air accumulates in hollows ("frost pockets") and also gradually builds up on flat areas from which there is little or no exit to lower levels ("frost plains"). The intending planter should, therefore, select sites where the risk of damage from radiation frosts is reduced to a minimum, i.e., on hillsides from which the cold air can readily drain away to ample "receiving areas" below, with relatively small higher "donor areas" above. These sites will not afford protection from "wind frosts," but luckily these occur less frequently than radiation frosts. (See photographs reproduced on page iv of art inset).

Even the grower whose established trees are in a "receiving area" can do something to lessen his risks. The conversion of trees to late-flowering or relatively frost-resistant varieties by frameworking or top-grafting methods is now a fairly simple procedure. Examples of late-flowering apple varieties are: Edward VII, Crawley Beauty, and Royal Jubilee. Worcester Pearmain and Ellison's Orange are fairly resistant; and Conference pear will, in fact, often set seedless fruits, even when the flowers are to some extent damaged by frost.

The effect of ground cover also is now known. Grass, especially long grass, or any insulating layer such as straw, causes the air above it to cool more than air above bare soil. Cornford found the minimum temperature at 3 feet over a grass meadow was about 3°F. (and in one case 6°F.) colder than that over bare soil or within woodland. Later work at East Malling suggests that the differences between orchards in grass and in cultivation are less. Measurements in comparable orchards throughout three blossom seasons have shown that on the twenty-eight nights when at least one thermometer registered 32°F. or below, the mean difference between grass and cultivated areas was 0.5°F. at 3 feet and 0.6°F. at 5 feet 6 inches. The greatest difference recorded was only 2°F. Even so, it is clearly desirable to keep this risk to a minimum during blossom time by removing weeds and keeping grass short. Similarly, the strawing of strawberries should be delayed until the risk of frosts has passed.

The use of a pruning method, such as "renewal" pruning, which produces many fruit buds on young wood as well as on older spurs, has also been shown to spread the blossom season and so give a greater chance of escaping frost damage (4).

A new Branch of the Meteorological Office (M.O. 19) is now helping to deal with meteorological problems relating to agriculture, and one of its activities is the summarizing of frost records to show the risk of frost incidence in various areas. The broadcast frost warnings, issued by the Meteorological Office, now help growers to prepare any necessary palliative measures and give the amateur a chance to put protective coverings over tender plants.

Orchard heating with small oil burners has been found effective in certain limited areas, but, since it is laborious and costly, other protective measures are now being sought. These include infra-red heaters and air circulators, as described below.

Other methods of preventing or lessening frost damage which have been tried by workers in various parts of the world include attempts to maintain bud temperatures above the danger point by spraying continuously

with water, by irrigation, by soil heating, and by smoke screens and chemical mists to reduce radiation. None of these, in the forms tried, seems to have given results good enough to justify general recommendation.

Indirect methods include the breeding of resistant and late-blossoming varieties, spraying or injecting various substances to increase resistance, prolonging dormancy, setting of fruits by hormones, and fertilizers. Work on all these subjects up to 1945 was reviewed by the Imperial (now Commonwealth) Bureau of Horticulture (8). Bush (2) also discusses many of these points in detail.

New Research Work: PALLIATIVE MEASURES By arrangement with the Director of Fuel Research (Dr. A. Parker), two members of the staff of the Fuel Research Station, Messrs. C. Baker (physicist) and C. P. Sayles (engineer), are now tackling the problem of orchard heating, wind circulation and similar measures. The resources of the Fuel Research Station have been augmented by a mobile laboratory to facilitate work in orchards where heating and air circulation are being carried out on a commercial scale.

In order to calculate the requirements to mitigate frosty conditions of differing degrees of severity, a preliminary theoretical study has been made of the heat exchanges between fruit buds and their surroundings under various conditions of radiation and wind speed.

The latest literature on heaters and air circulators has been studied, and laboratory and field tests have been carried out on various kinds of modern equipment. For example, it has been observed that the hot gases from certain orchard heaters rise out of the orchard without contributing much to the warming of the trees, and thus the effectiveness of these heaters is due to radiation. The distribution of the useful radiation output can be modified fairly simply, but it is doubtful whether the improvement would outweigh the trouble and expense of the necessary adaptors and the probable increase in the smoke output from the appliances.

Large radiation heaters distributing infra-red rays over a wide area have important advantages, and an experimental appliance has been built and tested. The fundamental difficulties inherent in heating by radiation are: (1) the trees near the heater receive more heat than is needed, while those far away get relatively little, and (2) as radiation travels in straight lines, sharp shadows are cast by obstructions, and shaded buds receive no radiation. It may be found possible, however, to evade these effects to some extent. The use of wind machines, including helicopters, has been considered. An experimental air circulator has been assembled and has provided information likely to lead to an improvement in performance of such machines.

The National Institute of Agricultural Engineering is also experimenting with air circulators and testing large horizontal fans similar to those which have shown promise in Australia. An account, by the Head of the Institute's Horticulture Department, of some of the problems involved has recently been published in the *Agricultural Engineering Record**.

BIOLOGICAL ASPECT With the willing support of Dr. R. G. Hatton, work on the reaction of fruit plants to frost has been intensified at East Malling Research Station. Two special frost research rooms have been constructed, in which accurate control of low temperatures can be maintained; in one of them, very low temperatures, such as are experienced in severe winters, can be reached if desired. Since 1946 Dr. I.

*Winter 1948–49, 6.

Modlibowska, whose work on winter frost damage is well known, and a post-graduate worker have devoted much of their time to spring frost research, under the general supervision of the writer of this article. A further research worker and an assistant have now been appointed.

The programme includes research into the nature of frost injury and all the factors that may affect the susceptibility and resistance of fruit plants. Much of the work in 1948 was devoted to testing the new experimental chambers and finding the best methods for freezing experiments, e.g., comparing different degrees of frost and different periods of exposure. The type of material used—trees in pots, cut spurs, or single flowers—has also proved to be important, and a preliminary study has been made of variation in damage from tree to tree, spur to spur, and flower to flower within a cluster. A start has also been made with the study of various factors, including age of flower, pollination, phase of bearing, rootstock, amount of foliage, moisture conditions, etc., in relation to frost resistance.

Temperature changes within the bud have been measured by very fine wire thermo-couples inserted in the bud, with indicating apparatus so sensitive that temperature changes caused by holding one's hand a few inches away are detectable. Using this method it has been possible to follow the freezing and thawing of a bud from minute to minute and so determine the degree of undercooling before freezing and the exact moment and temperature at which freezing of the tissue takes place. At that moment the latent heat of freezing of the water in the tissues causes an appreciable increase of temperature.

An important side of the work is the assessing of the frost resistance of commercial varieties and new seedlings. An effort is being made to find correlations between frost resistance of blossoms and any character which can be found in young seedlings, with the object of enabling selection at an early stage. If such can be found, the production of more frost-resistant varieties will be increased considerably. The breeding of such varieties has been on the programme of East Malling Research Station and several other institutions for some time, and good supplies of material for test should be forthcoming.

Detailed records are, of course, also being maintained on frost incidence in various field trials, in relation to factors such as rootstock, pruning, manuring, and ground cover.

This review does not claim to be exhaustive. Various other aspects of frost damage are being studied by workers at universities and other institutions, and by commercial firms and private growers. Work in Scotland includes studies by Dr. J. Grainger and Mr. D. Booth at Auchincruive, Ayr, during the last three years. Much research is going on abroad, especially in the U.S.A. and Australia.

The problem is certainly difficult, since basically it involves either making substantial local changes in certain natural climatic conditions, to suit existing plants, or else changing the plants to suit the climatic conditions. It would be over-optimistic to expect that any simple and complete solution will be found quickly; but careful and patient research, possibly over a long period, may be expected to yield considerable further advances.

The writer wishes to thank Dr. Modlibowska and Messrs. Baker and Sayles for help in preparing this review.

References

1. CORNFORD, C. E. Katabatic Winds and the Prevention of Frost Damage. *Quarterly J. Roy. Met. Soc.* (1938), **64**, 553.
2. BUSH, R. *Frost and the Fruitgrower* (1945), 119.
3. BUSH, R. Frost and Fruit. *Agriculture* (1946), **53**, 411.
4. ROGERS, W. S. and PRESTON, A. P. Renewal and Established Spur Pruning of Mature Apple Trees. *Ann. Rep. East Malling Res. Sta.* (1946), 49.
5. IMPERIAL BUREAU OF HORTICULTURE AND PLANTATION CROPS. Spring Frost Damage in Orchards and its Possible Prevention. *Tech. Comm. No.* 15 (1945), 22.

FARMING AFFAIRS

Pit Silage, 1948-49: Mid-Wales Experience A considerable number of pit silage samples have recently been examined at the Ministry's Experimental Husbandry Farm, Trawscoed, and analytical results of the samples tested show that silage made by the pit method has turned out very well. Particular attention should be given to the following points when making pit silage:

SELECTION OF SITE. The site of a pit silo should be well drained and have a low water table.

FILLING THE SILO. Very efficient consolidation can be obtained by using a tractor when filling a silo of this type. Mature material that would probably badly overheat in a cylindrical silo has been well made and satisfactorily fermented in a pit silo. On the other hand, there has been a tendency to over-consolidate the more leafy material, so that the resulting silage undergoes a butyric type of fermentation. When immature leafy crops of high moisture content are ensiled, the material for the first filling should be wilted in the field for a few hours before being placed in the pit. When dealing with such crops, each 3-4 feet layer of material added to the silo should reach a temperature of about 90°F. before more material is added.

ENSILING WET CROPS. Whilst it is true that silage can be made under conditions unfavourable for haymaking, it is inadvisable to ensile material soaked with rain water. Ensiling wet leafy material will generally lead to a butyric type of fermentation, and a better product can usually be obtained with dry crops.

SEALING. In most cases pit silos are sealed with some of the excavated soil, but the efficiency of the seal varies with the type of soil. A clay soil makes a good seal, whilst a gravelly or light, stony soil makes a poor one. A seal of the latter type is useful in weighting down the surface layers to prevent their overheating, but does not prevent the entry of rain water. Under Welsh conditions of high rainfall, the large surface area of a pit silo, covered with a porous soil seal, can allow a tremendous seepage of rain into the silage. Where the soil seal is porous, galvanized iron sheets can be placed over the pit to give more effective protection against rain. The surface of the silage should slope off from the centre to the sides. The central dome can be built up from straw and rushes, and this may also prevent soil contamination of the surface layer of silage.

PERIODICAL INSPECTION. After the soil has been added, settling will continue for some time, depending on the consolidation and rate of filling of the material into the silo. The seal should be inspected periodically, and

any hollows or cracks earthed up. As far as it is possible a pit silo should be filled so that the settled silage is a little higher than ground level and any rain water can run off the curved surface and away from the sides. Where the pit has walled-up earth sides and the material has settled below the level of these side walls, rain water will be trapped near the sides and will seep through into the silage, thus causing side waste. In such cases the side walls should be trimmed off level with the settled silage.

John R. Lloyd.

Whey-fed Pigs Where there are no arrangements for drying or condensing whey it is important to use the surplus whey for pig feeding if possible. This provides a supplement to normal rations and home-grown feedingstuffs; to meet cases where more meal is required to enable the whey to be consumed, County Agricultural Executive Committees have been authorized to issue the following allowances of cereal feedingstuffs *as an alternative to the normal rations*:

Until the end of June — 1 lb. for every 2 gallons of whey fed to pigs.
During July to October — „ „ 1½ „ „ „

Applicants will need to provide evidence or estimates of the quantity of whey to be fed to pigs in specified months. Rations issued against estimates will be adjusted later on production of documentary evidence. This supplementary cereal allowance cannot be granted when whey ceases to be available. Pig feeders should, therefore, in their own interest adjust their operations before cheese-making ceases, so that their resources will suffice to complete the fattening of the pigs or to allow of their sale to other fatteners.

RISK OF TUBERCULOSIS. The incidence of tuberculosis in pigs fed on whey is high, and in such pigs the disease is often acute. Consequently, the carcasses of pigs fed on whey are more frequently condemned on account of tuberculous infection than those of other pigs. To guard against this danger, *all whey should be boiled* before it is fed to pigs.

Nature Month by Month—May The "merry month" brings new beauty with each new day: the lovely pink-and-white candelabra of the horse chestnut, greensward spangled with the gold of buttercups, hawthorns laden with white blossom like masses of piled-up snow. In the wood the bluebells form an unbroken carpet of blue; on the crest of a rise, where the trees have been felled, they blend so nicely with the bright spring sky that one can hardly tell where bluebells end and sky begins.

Winged insect life grows more and more prolific. Bees, hoverers and others visit the wayside flowers. There are many butterflies, and the lanes are gay with dainty orange-tips. In the shadier parts of the lanes the first brood of speckled-woods is out, and on the rough waste land there are at least three kinds of skippers.

On and by the river there is much wild life. A moorhen leaves its nest in the sedges and swims jerkily into midstream. A water-vole, disturbed by the bird's passing, makes for a submerged hole in the farther bank, swimming under water very quickly in a dead straight line, its fur luminous with clinging air bubbles. A flash of turquoise blue comes downstream, alights upon a jutting alder branch and resolves itself into a kingfisher. On the farther bank a pair of swans have raised their great mound of a nest, on which the hen now sits patiently. In the tail of a pool a fat trout rises lazily to a drifting dun.

Up on the moor, curlew and redshank are brooding, and trim sandpipers are prospecting at the river's edge. The gorse is very bright with blossom now, and the ling shows rich new growth. New greys and greens of moss and lichen decorate the boulders, and the slopes of the tor, which a few months back were rust-red with dying bracken, are clothed in tender green.

The vicarage rookery is at its busiest and noisiest, for the nestling rooks are well grown and hungry, as all young birds are. In the orchard a pair of lesser-spotted woodpeckers pop in and out of the nest hole in an old pear tree. They, like the parent rooks, are full of family affairs. On a fir in the vicarage garden sits a hen cuckoo, watching patiently the movements of a pair of dunnocks in a thorn hedge below. Not for her the cares of parenthood; once her egg is "boarded out" with the unsuspecting dunnocks, she will seek another pair of victims for the greatest confidence trick in nature.

Daily the sun grows in power, awakening new life in field and hedgerow. The days draw out, and soon high summer will be here. *F.H.L.*

BOOK REVIEWS

Methods of Test for Soil Classification and Compaction. (*British Standard* 1377). BRITISH STANDARDS INSTITUTION. 7s. 6d.

Standard methods for the determination of the moisture content, liquid limit, plastic limit, plasticity index and liquidity index of soils, of the specific gravity and size distribution of soil particles, and for some soil-compaction tests are described with full working details. The methods are intended to be used in road-engineering work, but many of the details were worked out originally for agricultural soils, and some of the methods could advantageously be adopted as standards in agricultural work. *G. V. J.*

1949 Year Book of Poultry Association of Great Britain. S.P.B.A. Supplies Ltd. 3s.

The Poultry Association of Great Britain's Year Book for 1949 gives an up-to-date picture of many aspects of the poultry industry. The post-war position in England, Scotland and Wales is covered by three different authorities, Dr. R. Coles, Miss M. M. MacLeod, and Mr. H. Busher, each of them familiar with the varying conditions in the respective countries.

Fowl Pest has caused much anxiety to poultry-keepers recently, and they will be glad to have Dr. R. F. Gordon's review of the history of this disease and his summary of the present position. Mr. J. D. Blaxland, of the Ministry's Veterinary Laboratory, Weybridge, explains the limitations of post-mortem examinations, and discusses how far they can be helpful in the diagnosis of disease. Another contributor summarizes the main points in the papers read at the Eighth World's Poultry Congress.

There is a most interesting article on the fascinating subject of hormones, by Mr. J. O. Latham, the Association's Technical Adviser. His discussion of this comparatively new and highly technical matter has the great merit of being in language which can be understood readily by the layman.

Amongst other contributions there is one dealing in a general way with environment, another giving practical advice on the fold system, and a third, by J. R. Harvey and F. D. Dymond, providing a topical account of Income Tax regulations. The publication is readable and well illustrated, and it should be useful for reference. *J.W.S.*

"AGRICULTURE"

Price 6d. net monthly, post free. (Foreign countries, 8d. post free).

Subscription Rates (including postage):

Inland and Imperial	6s. per annum
Foreign Countries	8s. per annum

Subscription may start with any issue and should be sent to

H.M. STATIONERY OFFICE,
York House, Kingsway, London, W.C.2; 13a Castle Street, Edinburgh 2;
39 King Street, Manchester 2; 2 Edmund Street, Birmingham 3;
1 St. Andrew's Crescent, Cardiff; Tower Lane, Bristol 1;
80 Chichester Street, Belfast.

Single copies can be purchased from any of the above-mentioned addresses or through a bookseller.

Printed in Great Britain under the authority of HIS MAJESTY'S STATIONERY OFFICE by C. Nicholls & Company Ltd., The Philips Park Press, Manchester, London and Reading.

Please mention the JOURNAL *when corresponding with Advertisers*

FARMERS' FORUM No 1

"I've been riding tractors since they were pups!"

SAYS HERBERT MOSS, HEAD DRIVER ON MR. BRITTAIN'S HIGHLY MECHANISED FARM AT FELIXSTOWE, SUFFOLK.

"... and for running firmly along the top of the furrow — especially when finishing off, or starting a new stetch — give me the non-slip grip of Goodyear Sure-Grips every time."

FARMING TODAY demands scientific planning and maximum mechanisation. For every job on the farm there's nearly always a short period when weather and soil conditions are ideal. If you are equipped with the tractors and implements to get it done while conditions are at their best, you gain time, and you've got all your resources lined up for the next job.

This is the modern, go-ahead outlook; the outlook that will solve Britain's food problem by making us as near self-supporting as we can possibly be.

Goodyear farm tyres are all designed to get the job done quicker, with less implement "judder". In particular, the Goodyear Sure-Grip Tractor Tyre with its famous o-p-e-n c-e-n-t-r-e tread, gets your tractors through more work in less time than you ever thought possible. Look at those mighty lug-bars! See the bite-points? . . . They dig deep into the ground, followed by the whole length and breadth of the lug-bars. Four-at-a-time those rugged self-cleaning Goodyear bars drive the tractor forward, extracting the uttermost ounce of power from your engine by sheer, down-to-earth *wheel-adhesion.*

Speed the plough with

GOODYEAR

SURE-GRIP TRACTOR TYRES

and grow more food for Britain

Please mention the JOURNAL *when corresponding with Advertisers*

Please mention the JOURNAL *when corresponding with Advertisers*

72-1-5-49

Agriculture

PUBLISHED 6^d MONTHLY

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

Editorial Offices : St. Andrew's Place, Regent's Park, N.W.1 (*Phone : WELbeck* 7711)

VOL. LVI　　No. 3　　JUNE 1949

Contents

Cover Photograph

Grass-fed Beef

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LVI | No. 3 | JUNE 1949

GRAIN STORAGE

Report of a Conference held at Maidstone on February 24, 1949

G. H. GARRAD

Kent Agricultural Executive Committee

MR. W. H. CASHMORE, Director of the National Institute of Agricultural Engineering, introduced the subject of the conference by saying that it is now generally accepted that the combine harvester has definite advantages over the self-binder. By its use one may expect to harvest more grain per acre and better quality grain. But as the number of combines increases so does the problem of drying and storing the grain.

This problem is tied up closely with the technique of operating the combine. During the war it was necessary for the Ministry of Agriculture to require that the limited number of combines available should cut the maximum acreage, and a fairly high acreage figure was expected of farmers when a combine was allocated to them. Experience has shown, however, that by using the combine a few hours less in the season one can reduce the need for drying. If one aims at 15 to 20 acres per foot of cut instead of 25 to 30 acres, a much larger proportion of the corn can be cut in such a condition that it requires very little or no drying. It is very difficult, however, to predict the weather in this country, and some provision should be available for drying damp grain as a safeguard against the occasional bad harvest.

The pressure of work in the harvest field can be eased by a careful selection of varieties of corn to extend the harvesting period. Many combine owners, in their anxiety to press on, are still guilty of starting to cut a field three or four days before the crop is ripe ; others wait until the crop is ripe and then carry on during a spell of damp weather when the corn is not sufficiently dry. The need for drying can be minimized by avoiding combining too early in the morning or too soon after rain, and by keeping on during meal times when the crop is dry. Wheat will stand after it is ripe better than barley, so if conditions are suitable for the combine to work and both crops are ready, preference should be given to the barley field.

Mr. Cashmore said that he had not had much success with windrowing as opposed to direct combining. A fairly extensive trial of the two methods was carried out in Oxfordshire, Worcestershire, Lincolnshire and Kent in 1946. Generally speaking, it was found that the rate of working was not appreciably increased by windrowing, and under some conditions a lot more labour was necessary. The total labour worked out at 7.8 man-hours per acre for the windrowed crop, as compared with 3.8 man-hours for the straightforward cutting. Losses of corn are much the same except with barley, where windrowing saved some corn. With laid crops, windrowing definitely increases the loss. One must have six inches of upright stubble on which the windrowed crop can lie, and there is not such a stubble in a laid crop.

In the case of oats there will be a higher feeding value in the straw if the crop is windrowed when still slightly green as compared with a crop which is left standing until it is dead ripe for direct combining. With a weedy crop, too, windrowing may be a real help in dealing with the green rubbish. But after a heavy rain which has soaked into the windrows a standing crop dries more quickly. Mr. Cashmore admitted, however, that the technique of his trials may have been faulty, and he is not yet prepared to give a final answer on this question of windrowing.

The moisture content of grain has been measured over a number of years. The temperature of the hot air should never be allowed to exceed the following limits, even for a few minutes :

	deg.F.
Oats and dredge corn, except for seed	180
Wheat for milling	150
Barley and seed corn containing up to 24 per cent moisture	120
Barley and seed corn containing over 24 per cent moisture	110
Linseed, mustard, and other oily seeds	115

A moisture-meter on the drying plant, although helpful, is not essential once a man has become experienced in judging the moisture content of grain.

For safe storage the amount of moisture in the grain should not exceed the following figures :

	per cent
Long-term bulk storage	14
Short-term bulk storage	14—16
Long-term sack storage	16—18
Short-term sack storage	18—20

In trials carried out in Bedfordshire during the wet harvest of 1948, 43.5 per cent of the combined grain contained more than 20 per cent moisture and needed drying ; 17 per cent contained more than 22 per cent moisture. When moisture exceeds 20 per cent, grain must be dried or turned until dry. About 40-60 per cent of combined corn requires drying, but much of it only needs the removal of 3 or 4 per cent of moisture

Grain driers are very expensive to construct and install on a farm, but they do their work well in making the grain safe for storage. Today, many have thermostatic control and the amount of grain damaged in drying is very small. Some merchants will condition corn for their customers, but this service is limited by the fact that merchants are unwilling to dry grain containing more than 18 or 19 per cent moisture because it is costly to dry, and they dislike taking grain at all hours of the day or night, especially at weekends. One cannot, therefore, rely entirely on merchants.

Mr. Cashmore explained that there is a tendency for the manufacturers' figures regarding the capacity of their grain driers to be on the high side. The reason is that in the early days the capacity was calculated on the basis of drying at a temperature of 180°F. It was found that at this temperature some grain gets damaged, so the operating temperature is now reduced to 150°F. A drier rated at 2 tons per hour at a temperature of 180° F. will not dry the same quantity at a temperature of 150°F. The "tons per hour" is based on the assumption that 6 per cent moisture is taken out. A drier that removes 6 per cent moisture from a ton of grain at 150°F., will remove 4 per cent moisture from 1½ tons of grain in the same time. As the amount of grain dried per hour depends both on the temperature and on the amount of moisture to be removed, Mr. Cashmore suggested that in a normal season a 1-ton per hour drier working 10 hours a day can handle about 400 tons of grain in a season. Smaller driers are obtainable, but they are in comparison more expensive than the larger ones. For small farmers a co-operative drier is a possibility ; but it means double transport if the farmer wants his grain back, and there is the difficulty of keeping samples separate and of dealing with small quantities.

It should be borne in mind that in 1939 there were only about 150 combine harvesters in this country, that about 6,900 were in operation for the 1948 harvest, and that the number is continually increasing. So the drying and storage problem becomes more important every year. About 900,000 tons of grain were combined in the 1948 harvest.

A grain storage plant on the farm is costly but may be well worth while. One can either convert an existing building, which is usually a complicated and expensive business, or one can erect silos, either pre-cast or built on the farm. Concrete silos appear to be the best solution to the problem. It is unlikely that more than three-quarters of the grain combined will have to be stored; but even on a farm with only a small combine, at least six silos will generally be needed for separate storage of different kinds of grain.

Ventilation of grain in bulk by passing a trickle of cold air through the mass was tried as an experiment by the National Institute of Agricultural Engineering several years ago as a likely means of preventing grain from going mouldy until it could be dried in a standard drier. It was found that if the moisture content is above 23 per cent the grain cannot be held for more than a few days by this method, but that periods up to 21 days are possible with grain containing not more than 20 per cent moisture. The amount of actual drying, however, was small, so it was decided to carry out some trials with the use of heated air for ventilation. These experiments have culminated in the ventilated bin installation at Pitstone, Bucks, described by Mr. Hawkins (p. 96).

The principle of the ventilated bin is that air is blown through the grain at a temperature of 75° to 80°F. It is a slow process and is not suitable, therefore, for grain containing more than 20 per cent moisture, because such grain cannot be reduced to a safe moisture content quickly enough before moulds develop on the grain. The rate of drying is slightly more than at the rate of ½ per cent reduction in moisture content per day, which means that it would take about eight days to remove 4 per cent of moisture. The cost of operating, however, is very cheap (less than 6s. per ton) and the ventilated bins serve the purpose of both drier and storage silo. It is expected that there will be 15 or 20 of these plants erected in time for the 1949 harvest.

Whether a farmer dries his corn with a standard drier or whether he uses a ventilated bin, pre-cleaning to remove the green leaf or other green material mixed with the grain is an essential part of the equipment before drying starts. It is these small bits of greenstuff that are the real source of trouble, because they hold a lot of moisture, promote moulding of the grain, and also tend to prevent the free flow of air in any ventilating plant. The use of a pre-cleaner will save a lot of drying.

Experiments with drying in sacks have been carried out by the N.I.A.E. Two-bushel sacks, three-quarters full, have been placed on a grid constructed over an air duct through which passes a current of warm air which is forced through the grain in the sacks. With air at a temperature of 80° to 90°F. it is possible to reduce the percentage of moisture in the grain by 6 per cent in 6 hours. Care must be taken to see that the sacks completely cover the apertures in the grid. The experiments have indicated that it is unnecessary to turn the sacks during drying by this sack method, and this, of course, has an important bearing on the labour cost. The trials, however, are not yet completed and the method has not yet been tried out on a commercial scale.

A skilled man is not required to operate the ventilated bin or the sack drier, but a skilled man and constant supervision are necessary for the standard grain drier. The ventilated bin method and the sack drying method have the advantage that the grain can be dried to the right amount of

moisture ; most of the trouble with the standard drier arises not from the grain being overheated but from its being over-dried or under-dried. Before purchasing a combine a farmer should always consider how he is going to handle his grain when he has combined it and what he is going to do with the seed.

In reply to a question, Mr. Cashmore said that the maximum temperature that can be used for drying barley is 120°F. ; this allows for a slight variation, which one gets even with a thermostatic control. If the grain is very wet, a temperature of 110°F. should be the maximum, but if the grain is fairly dry and a large amount of moisture is not being removed, one can go up to 130°F. With most grain driers 1 per cent of moisture is removed in 8 to 10 minutes. If the moisture content exceeds 23 per cent it may be necessary to dry the barley in two, three or (in some cases) four operations ; there will be no harm to the barley, provided the temperature does not exceed 110°F. The maltster dries barley down to 11 or 12 per cent moisture for long-term storage in bulk.

Asked as to the relative cost of heating the air in a ventilated bin with electricity as compared with oil, Mr. Cashmore said that the cost of oil firing will probably be 40-50 per cent that of electricity, but in his opinion electrical heating installations are economical provided that the whole system is designed for using electricity. It is easier to maintain a constant temperature with an electrical installation than with oil or coke heating. Quite a lot of the drying is done by the air itself, and for a large part of a typical autumn day drying can be effected with a fan without having to use any heat at all. For those reasons he considered an electrical heating unit is economical for ventilated bins, but with a grain drier of orthodox type it is a different proposition. In the past, grain driers have been designed mainly for coke heating, but the question of efficiency has not been studied as seriously as it should be.

In reply to a question about the Claas combine, Mr. Cashmore said that it was designed in Germany to suit German conditions and that the design was influenced by the fact that the rye crop has to be harvested in the wetter parts of Germany and the rye straw is very long. He did not agree with the questioner that a seed-dresser on all makes of combine harvesters would be a good innovation, because the grain may not always be dry enough for proper dressing. It is sometimes a disadvantage to have both head corn and tail corn on the combine ; the proper place to clean corn is in the barn. As regards having the straw baler attached to the combine, the total cost may be less than having a combine and a pick-up baler as two separate machines, but straw is not always dry enough for baling as it leaves the combine.

Storing Grain in Ventilated Bins MR. J. C. HAWKINS described the ventilated bin installation that was erected, with the technical help of the N.I.A.E., on his father's farm, Green Farm, Pitstone, Bucks, in 1947. His father has a combine harvester with a 5-foot cut and grows 150 acres of corn a year in addition to various seed crops—linseed, sainfoin, clover, cabbage seed, etc. It was necessary to have some kind of storage and no buildings were available which could be adapted for the purpose.

As a result of the experiment referred to by Mr. Cashmore, it was decided to effect combine drying and storage in one operation and to have not less than six bins or silos ; with less than that it would not be possible to keep the different kinds of grain apart. The bins could not be made more than 10 feet above ground level, because 10 feet is the maximum depth of grain that can be ventilated properly. The bins were made circular, and the walls consisted of this reinforcement plastered with a rough rendering of

concrete made with quick-setting cement with an inner and outer finishing coat of cement mortar.

It was decided to construct the bins with flat floors because, although this arrangement is bad for emptying, it is much cheaper and easier to make. If one had self-emptying bins with a funnel-shaped base it would reduce the capacity of each bin by about 30 per cent. Each bin was made with a false floor of porous blocks supported on spaced bricks so that the ventilating air entered over the whole floor area. This arrangement was cheaper than using malt kiln tiles, as Mr. Hawkins was able to buy enough foam slag blocks for £26 to cover the bottom of all six bins, and there are enough left over for two more bins. A difficulty with malt kiln tiles is that the perforations are liable to get blocked with broken grains of corn, weed seeds, etc., and the only effective way of clearing them seems to be with a knitting needle. The bins were made circular because this was more convenient, but square ones would work equally well; the ventilation would not be affected in any way.

Air is driven through the bins at not less than 12 feet per minute. Two fans—a reverse-curve medium pressure fan for ventilating the bins and a paddle blade high pressure fan for conveying—were installed. Both were driven alternately from the same 10 h.p. electric motor. One might expect it to be cheaper to have one fan for both operations, but a ventilating fan has to be designed so that a lot of air at a low pressure is delivered through ducts into the bottom of the bins, whereas for conveying the grain a little air is required at a relatively high pressure. If one fan were used for both purposes it would be inefficient in both cases, taking more power than it should. It was decided that it would never be necessary to ventilate more than four bins at any one time, so the capacity of the ventilating fan and the size of the ducts were designed accordingly. Insulation of the air ducts so as to conserve heat is most important for economy and efficiency.

It was intended to have a pre-cleaner to take out all green material from the grain before it went into a bin, but it was not possible to get one before harvesting began.

The plant was completed by erecting a Dutch barn over the whole of it —fans, electric motor, bins, etc. Experience showed that a certain amount of rain was liable to blow in under the roof of the Dutch barn and get into bins through the top, but this difficulty was easily overcome by fitting some skirting around the barn.

The main structure was built in 1947 by a bricklayer and his labourer with the help of labour already on the farm. The total cost worked out as follows:

	£	s.	d.
Materials	167	9	11
New machinery	311	5	8
Labour	220	19	2
Dutch barn	310	0	0
Total	£1,009	14	9

The total storage capacity of the plant is 150 tons, which works out at nearly £7 per ton of grain stored. If the erection had been carried out by outside labour the cost would probably have exceeded £10 per ton. A full report of the plant has been published by the N.I.A.E. in the *Agricultural Engineering Record*; reprints of this report are obtainable on application either to the N.I.A.E. at Silsoe, Bedfordshire, or to the County Advisory Machinery Officer (Mr. G. B. H. Spear) at Mote House, Maidstone, Kent.

The plant was ready for use in time for the 1947 harvest, but the weather was so favourable that it was hardly used at all. For the 1948 harvest it was invaluable, since there were 168 acres of corn, as well as various seed crops, to harvest in very unfavourable weather.

When the corn needs only a very little drying the bins can be filled to capacity, but if the grain is very damp it is better to half-fill two bins and pass air through, heated about 10°F. above atmospheric temperature, until the grain is dry enough to put the two lots together.

The percentage of moisture in the grain as it arrived at the plant varied between 15.3 per cent and 24.5 per cent and averaged 19.2 per cent moisture. Moisture was removed until it was brought down to 16.25 per cent. The total amount of corn dried in the 1948 harvest was 166 tons, and the total amount of water evaporated was about 6 tons.

The cost of electricity was 1.7d. per unit for power and 1.1d. per unit for heat and amounted altogether to £40 1s. (£27 for power to drive the ventilating fan and £13 for heating), or 4s. 10d. per ton of grain. No actual figures of labour costs are available, but Mr. Hawkins estimated that drying cost, for labour and power, without overheads, would be about 5s. 4d. per ton.

Oil or coke heating may be cheaper than electricity but it is easier to maintain a constant temperature with an electrical installation, and Mr. Hawkins pointed out that in this installation quite a lot of the drying was done by the air itself on warm sunny days, without having to use any heat at all. The total electrical current used was 3,820 units, of which about one-tenth was used for conveying and the rest for ventilating and heating.

In reply to a question whether the expense of the Dutch barn could not have been avoided by fitting a roof over each bin, Mr. Hawkins said that everything had to be put under cover—bins, pre-cleaner, fans, electric motor, etc.—and in his opinion it was more convenient and cheaper to have them all under one roof.

Asked how long the grain could be stored, Mr. Hawkins replied that provided the moisture was reduced to 16 per cent or less, the grain in a ventilated bin could be stored indefinitely. One of the advantages of having a ventilated bin is that if the farmer is doubtful about the condition of the grain he can switch on the ventilator fan and it is then possible to tell from the condition of the air after it has passed through the grain whether or not the grain is in good condition. One can always turn a bin pneumatically if one is worried about its condition.

Asked whether grain would not suffer damage when moved through a pneumatic conveyor Mr. Hawkins said that it is quite possible to damage some grain, especially if the end of the conveyor directs the grain on to the side of the bin. When starting to fill the bin a small quantity of grain will strike the bottom of the bin, but in a very short time the incoming grain will fall on to the grain already in the bin and very little damage will result.

Another questioner asked whether dry grain could not be drawn off from the bottom of a ventilated bin and conveyed to another silo which was not ventilated and so save the cost of having so many ventilated bins. Mr. Hawkins replied that the grain would tend to "funnel" because the bin outlet is at the edge of the bin. Even with the opening in the centre and a funnel-shaped base to the bins, it would still not be possible to draw off the dry grain at the bottom because of funnelling in the bin.

Standard Drier and Bins MR. R. O. ANDREWS, Chalton Cross Farm, Luton, Bedfordshire, said that many farmers have the idea that installing a drier and storage arrangements involves the expenditure of many thousands of pounds. But they can be put up much more cheaply than that. Not only will they justify their cost in the saving of labour and the extra return received for the grain, but they will also put the owner in the position of being able to hold his grain against a low or falling market.

In the opinion of Mr. Andrews, with the ever-increasing number of combines, farmers who do not make arrangements to store their grain will be driven to accept a low price for their corn at harvest; and even then they may not be able to move it off the farm for some time. With the expansion programme it is probable that more grain will have to be stored on the farm for feeding to livestock. For these reasons, and the feeling of security and independence which follows from the ownership of a grain drier and storage plant, it is good business for every combine owner to put himself into a safe position by having one. The proper place to store British grain is on British farms, but it is up to farmers to market their grain in proper condition and at the proper time; the day for marketing grain in damp and poor condition has passed.

The installation of a drier and storage can be a very expensive business if it is not properly planned and tackled in the correct way. Mr. Andrews' plant was largely built with farm labour. In 1944 he purchased eight precast concrete silos, 14 feet internal diameter, to hold 250 quarters each at 17½ feet high at £71 apiece; today they would cost £90 apiece. He also bought a pneumatic grain elevator for £66; today's price would be £90. In 1945 he bought an automatic weighing machine, capacity 252 lb., for £160, which today would cost £305. A dressing machine was bought for £185; today's price would be £290. He also bought a grain drier for £460 which today would cost £750. This grain drier was converted to electric heating at a cost of approximately £300.

Mr. Andrews gave the total cost of his plant for drying and storing 2,000 quarters of grain, with electric motors and extra ducting, at approximately £2,000. This figure does not include any building or installation costs, as all this work was done by his own farm labour in slack periods during the winter months.

He pointed out that capital today is cheaper than labour, and that £2,000 invested at 3 per cent comes to about one-quarter of one man's wages for a year. One must spend money, he said, to do the job properly and to make money. All the moving of his grain from drier to silo is done by pneumatic elevation; it is automatic and no human effort is required.

The pneumatic elevator does the filling of the silos, turning from one silo to another, emptying silos back to the automatic weigher for sacking off, and back to the wet grain pit for re-drying if necessary. It will turn 60 tons of grain from one silo to another for a cost of 7s. for electric power and can be left running all night without attention.

In Mr. Andrews' opinion electricity provides the ideal means of heating and controlling the air temperature in the grain drier, but it is dearer in running costs than oil. His electric heater has a thermostatic control, so that the air temperature is automatically maintained constant, fumes from the combustion of coke or oil are entirely eliminated, and the air that passes through the drier and the grain is free from taint.

Mr. Andrews pointed out that driers are not "ripening machines" and that grain must be fully ripe before the combine goes into the field; grain cannot be ripened after it has been threshed. Farmers should remember that the grain is alive. He estimates the temperature of the grain in his silos by putting a steel rod three-quarters of an inch in diameter into the grain and leaving it there. Each morning the rod is pulled out and by running it through his hand the operator can judge the temperature of the grain. It is a simple method but quite effective. The danger period of overheating is the first two or three weeks when the grain is in the silos.

In reply to a question as to the maximum depth of grain that can be put into a silo, Mr. Andrews said that provided the moisture content is brought

down to 15 per cent, it is quite safe to have a silo up to 17½ feet high. When pressed for room he has sometimes stored grain containing 16 to 17 per cent of moisture in these silos, but if this is done it is necessary to inspect the condition of the grain in the centre of the silo frequently and to be prepared to move the grain often from one silo to another. The air space between the blocks of the pre-cast silos helps with the storage.

Mr. Andrews, in reply to another question, said that the capacity of his conveying system is 45 cwt. per hour, but it is sometimes possible to work the drier faster in dry weather. If he were going to do the job over again he would install a conveying system capable of handling 4 tons of grain an hour to be on the safe side.

On the question of windrowing, Mr. Andrews said that oats are a crop that could be windrowed with advantage, especially if there is a lot of rubbish in the straw.

Sack Storage Mr. N. D. Reffell, Court Farm, Dorney, near Windsor, dealt with the subject of grain storage from the point of view of the smaller growers who have had no experience of combining and whose grain acreage does not warrant the capital outlay on an expensive plant.

Mr. Reffell has been combining for three seasons and has been able to manage quite successfully without the aid of a drier or silos. He farms 370 acres in the Thames Valley, all arable except 10 acres. His principal crops are potatoes, barley, oats, wheat, and pedigree grass seeds and clovers. The average rainfall in his district is 2.1 inches in August and 1.8 inches in September, but during the 1946 season it was 4.08 inches and 3.60 inches, and in the 1948 season 2.54 inches and 1.74 inches. This heavy rainfall makes the harvesting of cereal crops a difficult proposition.

In his first season with a combine (1946) he found that the grain was blown over the cleaning sieves when he tried to make a clean sample ready for sale direct from the machine. So he had to reduce the wind current. He then found that the threshed grain was not clean enough to dispose of because it contained short pieces of straw, bits of stubble, weeds, thistle heads, etc., so he took it to the barn and cleaned it with an old winnowing machine bought at a local farm sale for 4s. In that way he is able to take care of the waste and either use it at home or sell it for chicken feed instead of losing it in the field. His winnowing machine is driven by a 2 h.p. petrol engine and can clean ten 4-bushel sacks per hour, one man feeding the hopper and another sacking up and weighing.

By leaving the uncleaned grain standing in the sacks for 24 to 36 hours before cleaning, Mr. Reffell is able to take out the more "sappy" pieces, e.g., tare pods, short pieces of green weed, stalks, green thistle heads and the like, also quite a large proportion of green immature grains. During these 24 to 36 hours of standing this green material wilts and loses some of its weight, so that it becomes lighter and separates much more easily from the grain than it would do without this period of standing.

Before attempting to store the grain, either before or after cleaning, very great care must be taken to see that it does not contain too much moisture. Mr. Reffell trusts to the old-fashioned method of pushing his hand well into a number of sacks, biting a few grains now and again, and using his judgment and considerable experience. Farmers who do not possess the necessary experience can get the N.A.A.S. to carry out moisture tests for them.

Having satisfied himself that the grain is sufficiently dry for sack storage, Mr. Reffell arranges the sacks in rows with spaces apart and three sacks high. Care must be taken not to let the sacks come in direct contact with a con-

crete floor, otherwise the sacks become damp and the bottom soon rots. Old paper fertilizer bags are useful for standing the corn sacks on, as the inside lining of these bags is water-proofed. Sisal paper is also a suitable floor covering, or rolled out chestnut pale fencing, or wooden boards if they are available.

Grain stored in this way can be kept successfully until the spring. Steps must be taken to control rats and mice. Vermin damage can be very serious when hessian bags cost up to 1s. 8d. each and 4-bushel corn sacks up to 6s. and 8s. each, apart from the loss of grain and unnecessary work of cleaning up, re-weighing and sack mending.

The success of Mr. Reffell's harvesting and grain handling method is reflected in the fact that the lowest price at which he has sold barley this year is £5 5s. per quarter, and at least half the sales reached the maximum price. The secret lies in Mr. Reffell's very careful judgment as to whether a crop is ripe and whether it is dry before starting the combine in the field. His advice is:

"Don't be over-anxious to start. Because your neighbour has started cutting with his binder it does not mean that you can start with your combine. If you feel that you are getting left behind don't forget that the crop harvested with a binder has to stand in stook and then be carried, stacked and threshed. If you hope to use a combine without a drier you must wait until all the grain in the field you are going to harvest is ripe. If it is not ripe and dry, no winnowing machinery can ripen it or do very much towards drying it, and your storage troubles will be endless. Don't start work too soon after a shower of rain. Standing corn dries quickly, but don't expect it to dry too quickly. If you start too soon, the moisture content of the grain will be too high and you will have some damp grain to shoot out on the barn floor or to get dried in some other way. Don't start work in the morning before the dew has dried off. It is very seldom advisable to start work before 10 a.m. on the nicest summer mornings because of the dew which usually accompanies these mornings. On dull days it may be necessary to delay starting work until late afternoon or evening."

Mr. Reffell has an arrangement with his drivers to be on call on Saturday afternoons and Sundays at very short notice during the harvest season, so as to avoid losing a few hours of good working conditions. He has relief labour to take over the tractor and combine during meal times, otherwise two valuable hours of work can be lost. A man who owns a drier need not be quite so particular about the conditions under which his combine works, but for a man who has no drier it is all-important.

It has been Mr. Reffell's experience during the past three seasons that an 8-foot combine can be used successfully on up to 200 acres of grain crops without the aid of a drier or special cleaning plant. Some careful thought must of course be given to the varieties of cereals sown and the time of sowing, so that the season of ripening is extended as long as possible. One might, for example, sow one-third of one's barley acreage with Pioneer in the autumn, one-third with Abed Kenya in the early spring, and follow with Spratt or Plumage-Archer. In an average season there may well be a few days to a week's difference between each of these varieties ripening. Similar thought should be given to the choice of varieties of oats and wheat.

Mr. Reffell pointed out that his method involves the use of very little machinery and no expensive equipment—only an appreciation of the situation coupled with the use of commonsense. He recommended his method of storing in sacks to growers of a small acreage of corn. It does not involve expenditure of capital on machinery and equipment that has to lie idle and unproductive over a great part of the year.

Mr. Reffell concluded with the following warnings :

Don't try to make a clean sample direct from the combine. It is quite easy to clean the grain in the barn and far less wasteful than trying to make the combine do the cleaning.

Don't leave uncleaned grain in sacks more than twenty-four hours if it contains a large amount of crushed clover leaf, leaves of sow thistles or any other sappy material ; otherwise it may heat in the bags and the grain will suffer.

Don't think that grain in any condition as regards moisture content can be safely stored in sacks. The combine must be used with discretion. This restriction will not please a contractor whose main objective is acres per day.

Don't store sacks for any length of time on a concrete floor without first putting down a damp-proof floor covering.

Don't start to combine a crop before it is dead ripe and free from external moisture such as dew or rain. If you have unripe or damp grain and no drier you are in serious trouble.

Don't aim at too big an acreage with your combine. If you do, you will be working it when conditions are not quite suitable and then your cleaning and drying troubles will begin.

Don't sow your whole acreage with one variety, so that all the fields ripen at the same time. Spread your harvest and so avoid waste and unnecessary worry.

Summing Up Mr. C. E. Elms, Provincial Machinery Advisory Officer for the South East Province, in summing up, emphasized the fact that in addition to the 6,900 combine harvesters in use in this country last harvest, it is expected that another 2,000 combines will be available for the 1949 harvest and a further 2,000 combines for the 1950 harvest. The question of drying and storage, therefore, becomes more and more acute. He calculated that if each combine had an 8-foot cut and harvested 20 acres per foot cut, the 2,000 new combines would deal with 320,000 acres of corn and would need 3 million bags. He wondered where these additional bags were coming from.

The conventional type of drier with storage silos is satisfactory, he suggested, for the large farmer, but at today's prices he estimated that the cost of installing a drier, etc. and storage for 4,000 quarters of corn would be about £10,000. Something cheaper must be found for the smaller man.

For a man like Mr. Hawkins, with 150 to 200 acres of corn, the ventilated bin system seems to be the answer. He had obtained some up-to-date figures from a contractor who admittedly was branching out on a new line of business, but this contractor estimated that the cost of the bins, heating and everything else, but excluding the Dutch barn, would be about £1,100, especially if outside labour is used to do the construction work. He had seen a quotation put forward by a constructional engineer for erecting ventilating bins, and the reinforcement alone, using expanded metal, came to £40 for each bin. The total cost of the ventilated bin plant today, therefore, would be rather more than Mr. Hawkins' plant had cost him.

He suggested that there is room for some other form of heater to be designed for warming the air which ventilates the bins, because it is not every farmer who has electricity. He had made inquiries and ascertained that some oil burner manufacturers are prepared to fit an oil burner for £95, but this does not include a furnace, which would cost another £35. He thought that two more storage bins might well be added to Mr. Hawkins' plant, as his existing fan is quite capable of dealing with a further 50 tons of grain. Mr. Hawkins had never found it necessary to ventilate more than three bins at any one time and the average had only been two.

The man who is really going to be in difficulty, Mr. Elms suggested, is the small man with 60 to 70 tons of grain to store. For him, sack storage seems to be the solution.

COMMUNAL GRASS DRYING IN ENGLAND AND WALES

RESULTS FOR 1948

H. G. LAMBERT

Ministry of Agriculture and Fisheries

THE nineteen communal grass drying centres dealt with in this note are those set up by Government grant under the scheme announced in February, 1948, including one centre at Thornbury, established in 1947. The service was experimental, both as regards technique and the recording of results. There is, therefore, no uniform and comprehensive set of records, on the lines, for instance, of those issued by the Dutch Government for approved centres in that country*. Certain data were collected, however, and are now published for the information of those interested in this experiment.

It would be unwise to draw any firm conclusions from the figures at this stage, and no attempt is made to do so. They are useful not only as a statement of fact but as showing the wide variations from centre to centre in the principal items, such as cost per ton, total output, and protein content. We have a long way to go before these variations can be explained in terms of climate, form of organization, size of centre, and so on.

The Board and Co-operative Societies responsible were :

	No. of Centres
Milk Marketing Board	12
Cheshire, Shropshire and North Wales Farmers' Supply Association Ltd.	2
Gower Farm Services Ltd.	1
West Cumberland Farmers Ltd.	1
Wiltshire Farmers Ltd.	3

These bodies provided a grass drying service to neighbouring farmers, and centres were subject to inspection by the Ministry of Agriculture and Fisheries. Except for a small percentage, the whole output was returned to the farmers contributing grass or forage crops to the station.

The results are shown for the different centres by number, with an indication of the size of the plant, and are in two parts—first, the data on output, etc., provided by the organizations, and secondly, protein content measured after sampling by the National Agricultural Advisory Service and analysis in their laboratories ; the objective was to take three samples per week, but in some cases this number was not reached owing to pressure of other duties.

The types of drying plant included tray, conveyor, and high temperature (rotary drum). Plant listed as "small" indicates one drier normally regarded as being capable of an output of 4 cwt. per hour of dry material under average moisture conditions. A "medium" plant refers to one or more driers capable together of an output of between 8 and 10 cwt. per hour, and "large" plant indicates a corresponding figure of the order of 15-20 cwt. per hour.

The most striking features are as follows : costs per ton (Table 1) run from £13 to nearly £23 per dry ton. Taking the largest compact group (i.e., medium size) centres, we have the total output for the whole season ranging from 300 to 1,200 tons ; and low costs per ton are usually accompanied by high output. Note that cost means the cost to the farmer of the *service* provided, which was usually the complete service of grass harvesting, collecting and drying, and transport to the farmer.

---

* *Agricultural Information Service*, No. 4 (April, 1948). Dutch Directorate of Agriculture.

COMMUNAL GRASS DRYING

Table 1

Data Provided by

	Unit	Medium Plants								
		1	2	3	4	5	6	7	8	9
Throughput	tons	1,195	719	715	1,010	566	744	575	855	545
Cost per ton (estimated)	£	13.0	22.7	18.8	13.8	22.2	15.5	22.5	17.6	21.7
Working days	No.	161	158	153	167	137	139	150	155	137
Man-hours per ton	No.	28	35	34	32	41	41	42	30	55

(a) none given

Table 2

Protein Content of Dried Grass: May-October

(a) Percentages

Grade	1	2	3	4	5	6	7	8	9
A and B (over 15 per cent	11.6	26.2	6.5	14.3	17.2	12.9	14.0	13.9	31.8
C and D (11-15 per cent	53.6	51.3	43.5	46.9	48.3	50.0	49.6	52.8	40.9
Ungraded (under 11 per cent	34.8	22.5	50.0	38.8	34.5	37.1	36.4	33.3	27.3
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

(b) Average Protein

	1	2	3	4	5	6	7	8	9
Protein Content (average of all samples at each centre)	12.7	13.1	11.4	11.8	11.9	12.1	12.0	12.4	13.0

Note : Figures relate to per cent crude protein

ENTRES : 1948 RESULTS

.M.B. and Societies

					Small Plants			Large Plants		Total
10	11	12	13	14	15	16	17	18	19	
542	700	833	378	304	427	116	274	845	1,509	12,852
21.1	17.2	17.7	20.0	20.0	20.0	17.0	20.0	20.0	20.0	—
172	172	171	127	114	132	146	122	166	166	—
34	43	40	14.5	13.9	26.2	(a)	29.7	(a)	(a)	—

nclusive (from samples taken by N.A.A.S.)
n Grades

10	11	12	13	14	15	16	17	18	19	Average all Samples all Centres
40.8	16.0	12.5	32.0	24.0	8.9	40.9	11.9	12.7	14.5	18.4
27.4	48.0	50.8	48.0	56.0	55.7	46.9	66.1	34.6	38.1	46.3
31.8	36.0	36.7	20.0	20.0	35.4	12.2	22.0	52.7	47.4	35.3
100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

ontent

10	11	12	13	14	15	16	17	18	19	Average
14.1	12.8	11.7	13.5	12.9	11.9	14.4	12.3	11.7	11.5	12.4

n sample on 90 per cent dry matter basis

The next significant point is the range of protein content by centre (Table 2). In the top quality, for instance, centres have from less than 7 per cent to more than 40 per cent of the samples taken ; on the other hand, there is a certain degree of uniformity in the proportion below the datum line for grading purposes ; i.e., below 11 per cent crude protein content (on a 90 per cent dry matter basis).

The figures below show the monthly variations of protein content. In noting the gradual rise in the relative proportion in the higher grades, allowance must be made for the fact that building delays meant a late start at many centres and the organization was not running smoothly until late in the season :

Grade	May	June	July	Aug.	Sept.	Oct.
A and B (over 15 per cent)	6.6	4.0	12.6	30.4	26.1	31.1
C and D (11–15 per cent)	44.3	24.3	36.1	59.3	59.0	57.7
Ungraded (under 11 per cent)	49.1	71.7	51.3	10.3	14.9	11.2
	100.0	100.0	100.0	100.0	100.0	100.0

A footnote is necessary on the measurement of protein content. The scale adopted by the Advisory Service relates to samples of dried grass approximately as received (for the sake of uniformity reduced to a common basis of 90 per cent dry matter). Some authorities quote the crude protein content of dried grass on a 100 per cent dry matter basis, which would mean applying a factor of 10/9 to the above figures, e.g., the top average of a centre of 14.4 per cent for the whole season is equivalent to 16 per cent on the 100 per cent dry matter basis.

Estimated figures of man-hours per ton are included ; but these should be regarded with some reserve. The basis of computation is not necessarily uniform between organizations, and in the first season it was necessary to experiment to determine the exact labour force required for the different types of plant.

POTATO SILAGE

J. C. Wallace, M.C., and J. K. Thompson, N.D.A.
Agricultural Institute, Kirton, Lincs

INVESTIGATIONS into the making of potato silage were first started at the Kirton Agricultural Institute in May, 1930, when surplus potatoes from the 1929 crop were incorporated with a green crop in a stack or clamp silo by the method described later in this article. The silage was fed to bullocks during the winter of 1930-31, and as a supplement to fattening cattle on grass during the following May, June, and July. The clamp was then closed, and re-opened in November. The silage had kept in good condition, and was readily eaten by stock.

Mixed silage of this kind is not suitable for feeding to pigs. For pig feeding the potatoes should be cooked, either by boiling or steaming, after which they can be ensiled in a concrete silo or in an outdoor pit silo. Properly made steamed potato silage will keep in good condition for two years or more.

POTATO SILAGE

From 1931 to 1939 steamed potato silage was made each year at Kirton for feeding to pigs, and it was found to be profitable to buy surplus potatoes for the purpose. They could be bought at £1 per ton or less, at which price they were much cheaper than barley meal. Four tons of potatoes are equivalent in feeding value to one ton of carbohydrate meal, so that at today's prices, when the cost of ensiling is added, they are slightly cheaper than barley meal.

There are three ways of making potatoes into silage: (1) by incorporating layers of tubers with a green crop in a clamp or stack silo, (2) by cooking the tubers, and placing them in an outdoor pit silo, and (3) by slicing the raw tubers, mixing them with a little fermented meal, and placing in a pit silo.

Method 1 cannot be used until towards the end of May, when a green crop becomes available. Silage made by this method is suitable for bullock feeding, but not for pig feeding. Method 2 may be adopted at any time when potatoes are available. Partly blighted tubers may be preserved by this method. Silage so made is especially suitable for pig feeding.

1. Admixture of Potatoes and Green Fodder

Silage composed of potatoes and green fodder has been made successfully on several farms in Lincolnshire, and bullocks fed with it made better progress than others fed on a normal, standard ration. The cattle readily ate the silage, and no trouble was experienced from its use.

At the Kirton Institute farm, some years ago, about 40 tons of seed and chat potatoes were mixed with the produce of about 9 acres of a one-year's clover and ryegrass mixture. This crop was cut in the middle of May, and with fine weather the green crop was carted immediately to a levelled site. A layer of green crop, 1 foot thick, was spread evenly over the ground. A layer of 1 ton of potatoes, previously riddled to remove soil and sprouts (and bagged for transport to the silo), was then spread evenly over the green crop. A run-over heap was made to secure the necessary consolidation. The green crop and potatoes were placed in alternate layers When complete, the sloping ends or ramps were cut away and the material thrown on the top. The following day a layer of about 6 inches of soil was placed evenly over the top and, a few days later, the sides also were covered with soil. Another layer of 3 inches of soil was also placed on the top.

When the silo was opened very little wastage was found. The mixed silage smelt sweet and pleasant, and where the heat had been greatest the tubers were partly cooked and quite sweet. Where there had been less heat, the tubers were white in the flesh and slightly tough. There was practically no seepage from the silo.

Feeding Trial

To test the value of the silage against an established method of feeding, six Lincoln Red bullocks were divided into two lots, and a ration of similar balance (in so far as the nutrient qualities of the silage could be estimated) was fed to each. The starch value and protein equivalent of the silage were the only nutrient factors unknown, but the figures would appear to be approximately: starch value, 17; protein equivalent, 1.4. The basis of the ration in one case was potato and green fodder silage, and in the other sugar beet pulp. The bullocks consumed the silage eagerly. The silage-fed bullocks were of better appearance, they handled better, and their skin was softer and more pliable than those in Lot B. It is of interest, too, that both lots made equivalent liveweight gains per day.

The following Table shows the average liveweight figures per bullock:

	Initial Live Weight			Final Live Weight			Gain per Day
	cwt.	*qr.*	*lb.*	*cwt.*	*qr.*	*lb.*	*lb.*
Lot A (Silage)	10	1	18	12	2	0	1.63
Lot B (Beet pulp)	10	1	9	12	1	18	1.63

2. Potatoes Steamed and Ensiled in a Pit Silo A pit 6 to 7 feet wide, 2 feet 3 inches to 2 feet 6 inches deep, with sides sloping slightly inwards, should be prepared on dry ground conveniently near the feeding pens. If water is likely to be troublesome, means should be taken to get rid of it. The potatoes should be cooked in a steamer or copper, and then well packed into the pit to avoid large air spaces. They should be built up well above ground into a ridge in the middle, as in an ordinary potato clamp. The sides and top of the ridge should then be covered with straight straw, and sealed with about a foot of soil.

Potatoes made into silage this way may be fed to pigs without any further preparation. Trials have shown that pigs readily consume this silage, and that thus fed they do as well as pigs fed on meals or standard balanced rations containing freshly-steamed potatoes.

3. Raw Potatoes Sliced and Mixed with Maize The steaming of potatoes adds to the cost of feeding, and for cattle it is neither necessary nor desirable. The potatoes can be sliced in a root pulper, and placed in a pit similar to that described under Method 2, together with a small quantity of fermented maize or barley meal.

The maize or barley meal should be prepared two days previously. It should be thoroughly saturated, but not made sloppy and allowed to become sour before being mixed with the potatoes. About 5 per cent by weight of soaked meal is required (approximately 1 cwt. per ton). The meal will increase in weight by about 75 per cent when soaked.

The pit should be finished off as already described. Silage thus made was readily eaten both by cattle and pigs.

Conclusions and Recommendations Experiments at Kirton have shown that (1) silage made from raw potatoes and green crop in alternate layers is suitable for feeding to fattening cattle, and (2) potatoes either freshly cooked or ensiled may safely replace carbohydrate meals in pig feeding, but they must be introduced gradually into the ration. They must not be fed in large quantities to young pigs. These should be weaned on to a full ration; thereafter a few potatoes may be introduced, and the allowance gradually increased. When four months old they may be brought on to a full potato ration, that is to say, the whole of the carbohydrate part of the ration may be replaced by potatoes.

As potatoes contain a smaller quantity of protein than the meals replaced, it is desirable to adjust the balance of the ration if the best results are to be obtained.

Potatoes may be fed to suckling sows in moderate quantities, if introduced into the ration 14 days after farrowing.

In-pig sows may be fed on a ration containing potatoes, but the quantity should be reduced as pregnancy advances, and omitted about 14 days before farrowing.

It should be stated that there is considerable shrinkage in ensiled potatoes. Watson* states that nutrient losses in outdoor, unlined pit silos are comparable to those with other materials. An experiment at Kirton suggested that 3 lb. of ensiled potatoes is equal in feeding value to 4 lb. of freshly-steamed potatoes. Further investigation is, however, required into this point.

It is recommended by some authorities that potatoes should be washed before being ensiled. We have never found this necessary at Kirton, but it may be in areas where much soil adheres to the tubers.

FLOODS AND THE SPREAD OF POTATO ROOT EELWORM

H. W. Thompson, A. Roebuck and B. A. Cooper
National Agricultural Advisory Service

THE thaw which followed the exceptionally heavy snowfall in February and March, 1947, resulted in the first place in the waterlogging or actual flooding of large areas of country. This was followed in some places by the bursting of river banks, and escaping floodwater swept across adjoining land with consequent scouring and washing away of vast quantities of surface soil, much of which was later deposited a considerable distance away. Much of the flooding occurred in the main potato-growing areas, and it was feared, therefore, that the rush of water over this land, which included considerable areas known to be infested with potato root eelworm, might have resulted in the widespread distribution of the eelworm, and that fields previously free might now be infested. This position arose in three provinces, in each of which an attempt was made to determine to what extent eelworm distribution had been affected as a result of flooding. In the Selby district, where the cereal root eelworm is also prevalent, and in the Nene and Welland areas, where the sugar beet eelworm is a problem, the investigation was extended to include these species. The areas studied were Selby (River Ouse), Trentside, Fens of Kesteven (R. Witham), the Crowland area (R. Welland), and Sutton Bridge (R. Nene).

River Ouse. The part of Yorkshire most severely affected by the floods was the area around Selby, where the Yorkshire Ouse burst its banks and flooded many square miles of country carrying a large acreage of potatoes every year and where eelworm is common.

River Trent. A large area of the Trent Valley, north of Gainsborough, was flooded when the Trent bank broke north of the village of Morton. The general direction of flow of the released water was northwards, parallel to the river, reaching to Keadby Bridge. Five or six miles north of Morton is an area around East Ferry that has had potato sickness for an appreciable number of years. This area was in the direct course of the flood stream, and was itself inundated for four or five weeks.

River Witham. The flooding in the Fens of Kesteven along the River Witham to the south-east of Lincoln was of a different nature from the flooding along the Trent Valley. This part of the country is intersected by many dykes or "delphs," which overflowed as the volume of water

* *The Science and Practice of Conservation—Grass and Forage Crops*, **1**, 404.

increased. As the level of the delphs became lower, the water gradually made its way back to them, only to come out again as more water came down from the Lincolnshire Heath. This overflowing with the return of the water occurred three or four times before the water was finally cleared.

RIVER WELLAND. Following the exceptionally high rainfall of the summer and autumn of 1946, the soils of North Fenland (the North Level) were unusually wet. Cowbit Wash is an area of grass some nine miles long and up to one mile wide, lying beside the River Welland, bounded by high banks built to collect and store up water coming down the Welland and to allow it to flow to the sea between tides when floodwaters have subsided. As a result of the provision of a new pumping station, Cowbit Wash had been dry during the previous four winters but became a lake again during November, 1946, and remained so until the thawing of the snows in March, 1947. On March 21, 1947, the banks of the Cowbit Wash opposite Deeping High Bank broke, and, as a result, between 15,000 and 20,000 acres of arable land in Holland, Kesteven and Peterborough were flooded, over most of the area to a depth of a foot or two and in some cases to a depth of many feet. The inundation reached its maximum expanse about April 10. The rush of water through the breach dug a hole 30 feet deep outside its banks, and many lumps of clay and soil from this vicinity were spread over fields within a quarter of a mile around, and the finer material was carried much greater distances. The area normally carried about 30 per cent of its arable area in potatoes, and a great many potato and mangold clamps were washed away, along with corn and straw stacks and other farm materials.

RIVER NENE. Much of the water from the Crowland breach found its way, not back into the Welland, but into the River Nene a few miles above Sutton Bridge. Eelworm cysts found in the samples examined below Sutton Bridge may, therefore, have been brought by waters emanating from the Welland, and which passed through an area heavily infested with potato root eelworm before reaching the Nene.

Sampling Data Samples of material deposited by the floods were collected in the three provinces involved and examined for the presence of cysts of the potato root eelworm.

OUSE AREA: GRASSLAND. To ensure that samples were taken only from fields where infestation did not occur originally, permanent grassland was chosen and sampling was restricted to the silt deposited on the surface by the floodwater. Composite samples of silt taken from several points at each site were collected. The normal flotation technique was employed for cyst counting and, in addition to recording the potato root eelworm (*Heterodera rostochiensis*), counts were made of the lemon-shaped cysts of the cereal root eelworm (*Heterodera major*), also prevalent in this region. Samples were taken at random throughout the affected area, and no attempt was made to select sites adjacent or near to known centres of infestation.

Many of the samples, as was to be expected, showed no eelworm cysts present, particularly of the potato root eelworm type. Out of a series of ten silt samples, collected from fields in seven parishes, only at one centre was this eelworm found, while five centres showed substantial counts of cysts of the cereal root eelworm. Detailed counts are shown in Table 1. This series of samples, although indicating that eelworm cysts can be distributed by floodwater, gave little evidence of considerable distribution of potato root eelworm.

Table 1

Samples of Silt deposited on Grassland by Floodwater

	Centre	Wt. of Sample Examined *grm.*	Potato Eelworm Cysts	Cereal Eelworm Cysts
1.	Cawood	40	0	0
2.	Wistow	40	0	0
3.	Hemingbrough (a)	40	0	10 (3 viable)
4.	Hemingbrough (b)	40	0	8 (3 viable)
5.	Hemingbrough (c)	40	0	4
6.	Kelfield	40	2 (2 viable)	0
7.	Stillingfleet	40	0	0
8.	Barlby	40	0	7
9.	Escrick (a)	40	0	0
10.	Escrick (b)	40	0	4

Ouse Area: Debris. The normal method of cyst counting from soil samples depends on a flotation process. It was thought, therefore, that cysts might well be carried for considerable distances and deposited with other flotsam. In many instances large quantities of straw and other debris were deposited at the highest point reached by the floods, leaving a sharply defined high-tide mark across fields where flooding had occurred. Representative mixed samples of this material were collected and examined as before for the presence of cysts. As with the first series, samples were taken only from grassland, where normally infestation would not be expected to occur. These samples contained considerable numbers of cysts of both potato root eelworm and cereal root eelworm. The counts obtained, however, are not directly comparable with those of the first series, since, because of their strawy nature, the samples were very light in relation to their bulk.

A series of twelve debris samples yielded nine with some degree of infestation of the potato root eelworm, and all twelve yielded cereal root eelworm cysts. Detailed counts are given in Table 2. Checks for viability of the cysts were made on half the samples examined.

Table 2

Samples of Flotsam, Straw and Other Debris deposited at High-water Mark on Grassland

	Centre	Wt. of Sample Examined *grm.*	Potato Eelworm Cysts	Cereal Eelworm Cysts
1.	Newsholme	36	6	10
2.	Bubwith	21	36	80
3.	Bubwith	27	2	3
4.	Escrick	23	3	8
5.	Howden— Barlby Road	27	22 (4 viable)	5 (1 viable)
6.	Howden— Barlby Road	24	0	2
7.	Kelfield (Wharfemouth)	28	19 (6 viable)	20 (4 viable)
8.	Kelfield (Marshes)	34	2 (1 viable)	3 (0 viable)
9.	Moreby	26	21 (7 viable)	36 (7 viable)
10.	Riccall	40	0	2
11.	Howden— Bubwith Road	23	0	3 (1 viable)
12.	Howden— Bubwith Road	30	1 (1 viable)	2 (0 viable)

TRENT AREA: DEBRIS. A farm, five miles north of the East Ferry infested area, was chosen for intensive sampling. It had been almost completely flooded, the water having passed over the infested land. Nine arable fields that had been under water were sampled (50 samples per 10 acres) and in none of these was eelworm found. Furthermore, potatoes grown on land that had been flooded were examined for the presence of potato root eelworm, but no cysts could be found on the growing crops.

Sampling was also carried out in the East Ferry area as the floods subsided. Samples were taken from

(1) arable fields—the newly deposited silt only being taken;
(2) silt deposited on an inundated roadway;
(3) flood rubbish (straw, dead leaves, plus silt, etc.) that accumulated at the edge of the flooded area, and where the roads rose out of the flood.

Samples taken from (1) and (2) gave no indication of eelworm. Samples from (3) however gave positive results. 25 grm. of the detritus from the roadway gave a count averaging three viable cysts and six non-viable. Flood rubbish taken from the side of rising ground in the same area gave a count of six viable cysts per 25 grm.

The sampling carried out in these areas suggests that the cysts liberated from the soil have been washed principally to the edges of the flooded area. Any deposition elsewhere on the flooded land contained so few cysts that they were not detected by normal sampling methods.

WITHAM AREA: RESAMPLING OF FIELDS. This area has been fairly well mapped for eelworm, the populations of many fields having been estimated. Consequently sampling after flooding of such fields could be expected to give information as to any spread that might have occurred.

Table 3 below gives the results of typical fields sampled before and after the flooding.

Table 3

Before Flooding		After Flooding, 1947	Before Flooding		After Flooding, 1947
Cysts per 25 grm.	Year of Sampling	Cysts per 25 grm.	Cysts per 25 grm.	Year of Sampling	Cysts per 25 grm.
15	1946	13	2	1946	1
8	1945	1	8	1946	5
21	1946	17	1	1946	0
8	1945	0	3	1946	2
10	1946	7	6	1946	3
10	1944	35	0	1946	1
9	1945	14	1	1944	1
4	1944	18	0	1945	1
43	1946	19	1	1946	1
27	1946	18	4	1946	4
0	1946	0	0	1946	1
7	1946	3	0	1946	0
3	1944	10	3	1946	2
5	1945	15	1	1944	0
0	1946	0	15	1943	3
10	1945	4			

Of six fields sampled and found to be free in 1946, on resampling after the floods, three are still free, and the other three show a trace.

Several fields showed appreciable rises in population, but upon investigation were found to have carried a potato crop since the previous sampling. Taking into account the normal drop in population from 1946 to 1947 despite the flooding, it would appear that such increases were due to reproduction as a result of the potato crop, rather than as a consequence of flooding.

Welland and Nene Areas : Debris. A number of samples of straw and mud were collected from the high-water mark flotsam after the waters had subsided, and, after drying, were sifted and the finer materials examined, in 10-grm. samples, for the presence of eelworm cysts. Samples were examined from 18 sites. 11 out of 18 contained viable potato root eelworm cysts varying from 1 to 30 in 10-grm. samples. In addition, on seven of the eighteen sites, lemon-shaped cysts were found, with a maximum of two viable cysts per 10-grm. sample. Those could have been any of the beet, brassica, cereal or pea root eelworms, all of which have been recorded from the flooded areas. The most serious of these is the beet eelworm, on whose account many fields in the Eye-Newborough area are scheduled under the Sugar Beet Eelworm Order, 1942. The waters from these infested fields flowed over a considerable area in which the beet eelworm has not hitherto been recorded.

Previous Infestations in the Areas Studied Eelworm surveys have been made in past years for advisory purposes in many of the parishes affected by the 1947 floods. An analysis of this survey showing the proportion of infested fields is given in Table 4.

Table 4

Eelworm Survey Cyst Counts

	Parishes	No. of Fields Examined	No. of Fields Infested with Potato Root Eelworm	
Ouse Area				
	Cawood	95	76	
	Wistow	50	27	
	Hemingbrough	17	10	
	Kelfield	4	1	
	Barlby	11	7	
	Escrick	13	9	
	Riccall	2	2	
		192	132	Total
Trent Area				
	East Ferry	56	32	
	Greenhill Area	11	8	
	Laughton	6	6	
	Morton	11	6	
	East Stockwith	20	11	
	Butterwick	8	6	
		112	69	Total
Witham Area				
	Nocton	118	92	
	Potterhanworth	33	23	
		151	115	Total

Welland and Nene Areas

Fields in the area affected by the floods which have been sampled during the winter of 1947-48 show a proportion of about 80 per cent with some degree of eelworm infestation. From previous experience this would seem to be about the same proportion as before the floods.

The proportion of infested fields to the number examined as shown in the above tables is very high and may not represent the true proportion of arable fields in the area infested by the eelworm because sampling was undertaken with the object of advising farmers on potato cropping. Some selection was exercised, therefore, and the fields examined were mainly on farms where eelworm trouble had been met with in the past.

When due allowance has been made for this, however, it is clear that the numbers of infested fields are still very great, so that if flooding can result in increased cyst distribution, conditions were very favourable for it to occur in the areas studied. There appears, however, to be little evidence that this has taken place.

Cysts may not be Spread extensively by Floods The number of viable cysts present in the flood samples was much lower than is normally encountered in field samples in the area concerned. This may be explained by the fact that counts are normally made from soil samples which have been air dried. In these circumstances the cysts readily float to the surface when the sample is shaken in water. When kept in water, however, they become waterlogged and sink. A laboratory test to determine this loss of buoyancy was made. Seven series of cysts collected from air-dried soil, 20 in each series, were set up in tubes in water. At the end of twenty-four hours 52 out of the original 140 cysts had sunk to the tube bottom and after another twenty-four hours a further 43 had sunk, and the remainder readily sank when disturbed. For this reason cyst counts for advisory purposes are made only from soil samples which have been air dried; counts taken from wet soil are found to be unreliable.

A viability check on the cysts which sank showed that in every case the cysts which sank first were the cysts with the highest egg counts; that is, the most recently formed cysts. The older cysts, partially empty of eggs, were the last to sink. From this it is to be expected that flood-borne cysts would be more likely to include those of low viability, rather than the newer cysts.

The areas under consideration had been waterlogged for some time before the floods occurred, owing to melting snow. It seems likely, therefore, that few, if any, of the cysts would float, and their buoyancy would be relative only to the silt and other matter carried by the river floods. It is unlikely that eelworm cysts would be carried for any distance, except in rapidly moving water.

Conclusions The investigations made indicate that as a result of the floods there has been no widespread heavy infestation with potato root eelworm cysts of land previously free from the pest.

There has been a spread in small numbers to new fields, but appreciable new infestation has been confined to flood margins. Moreover the cysts carried were mainly those of low viability.

There appears to be no evidence therefore that "Potato Sickness" has extended greatly as a result of the abnormal floods and, subject to good husbandry, the small degree of new infestation which has occurred need not be considered serious.

The same remarks apply to the other cyst-producing eelworms attacking beet, peas, brassicas and cereals.

As regards beet eelworm, even the slight spread of this pest may be more serious to the farmer because it is the subject of a control order. A measurable infection would at once render the field subject to this order. Farmers in such areas, therefore, should crop with caution during the next few years.

COLORADO BEETLE IN JERSEY, 1948

T. SMALL, D.Sc., A.R.C.S.
States' Mycologist, Jersey

AS a result of the drastic precautions taken in 1945 and 1946, it was hoped that Jersey would be almost, if not entirely, free from the Colorado beetle in 1947. Unfortunately, however, a heavy seaborne invasion from the Continent occurred on May 28, 1947, when many thousands of dead beetles were found on the seashore and hundreds of live ones on the potato crops. Altogether 70 areas, the majority of them small, were officially declared to be infested ; they were treated with carbon disulphide during the winter of 1947-48 and planted with a trap crop of potatoes in 1948. All these areas except one remained free from the pest in 1948, and in the affected area only one beetle was found. There is also evidence to suggest that a small outbreak of 5 beetles in 1948 was caused by hibernants from the previous year. Thus, despite the heavy and scattered invasion in 1947, Jersey would have been almost free from the beetle had not yet another serious incursion from the Continent occurred in May, 1948.

1948 Invasion The accidental discovery of a single live beetle under seaweed on a beach at the extreme north-east corner of the Island on Sunday, May 16, was the first sign of the invasion. Further search over this beach revealed 27 beetles, of which 9 were alive, with flying wings outstretched. A rapid examination of all the Island beaches on May 17 and 18 showed that a heavy invasion had occurred ; many thousands of live and dead beetles were found on the seaweed at the high-tide mark and some had begun to climb into the crevices of the sea walls and on to large rocks out of reach of the tides. The biggest numbers by far were at the north-east corner of the Island, and from here the infestation continued with diminishing intensity along the whole of the east coast and also along the north coast for a distance of about five miles. Beyond this continuous infested coastal strip many dead but comparatively few live beetles were found on the beaches. One interesting and practical point concerned with the invasion was that, occasionally, beetles submitted for examination and thought to be dead revived in the laboratory.

At invasion time the tides were springing and a strong north-east to east wind was blowing, causing huge breakers which probably pounded and killed many of the beetles on the shore. Another fortunate circumstance was that the weather remained cool and overcast for several days, which prevented the beetles from flying inland to the potato crops and allowed sufficient time for the beaches to be treated. On May 19 it was decided to spray with 5 per cent DDT dust the line of seaweed (where most of the beetles were) and as many of the infested sea walls and rocks as could be reached by the available spraying equipment. Special spraying gangs were delegated to do this work by Messrs Plant Protection Ltd., who, as in previous years, were the spraying contractors for the Committee of Agriculture of the States of Jersey. The first application was given before the seaweed was disturbed, and the second immediately after the seaweed had been gently turned over to expose the beetles sheltering beneath ; in some cases a third application was given. By May 23, when the spraying was completed, very few live beetles could be found on the beaches. The last live beetle was found on June 10.

Attention was next concentrated on the potato crops growing within a belt one mile wide along the east and north coasts. These received a special additional spray and were very carefully inspected. Meanwhile growers throughout the Island were urged to inspect their crops, and the usual spraying of the whole of the crops was being carried out.

Within a few days of the invasion the available evidence suggested that, in contrast with the 1947 invasion, few, if any, beetles had travelled inland and reached the potato crops, and this was confirmed as the season progressed.

Crop Infestation Throughout the whole season only 89 live beetles were found on the Island. Of these, 70 were discovered in late August on volunteer potatoes growing among a $\frac{1}{8}$-acre turnip crop; all the beetles had soft wing cases and white flying wings, which indicated that they had only recently emerged from pupae in the soil. The infested crop was heavily dusted twice with 5 per cent DDT, and the soil was injected with carbon disulphide in August and again in November. Of the remaining 19 beetles, 5 were single finds and the rest were found within small areas in three fields, two of which contained volunteer potatoes among the root crops.

The only other live beetles found in Jersey in 1948 were discovered on May 18 on a yacht in St. Helier harbour; the yacht had left Granville at 2.30 p.m. on that day, and on arrival in Jersey at 6 p.m. on the same day 1 beetle was found on deck and 1 on passenger luggage.

Conclusion During the past two seasons extensive and costly measures have had to be taken in Jersey, not to combat the few hibernating beetles persisting in the Island, but mainly as a precaution against the possibility of heavy incursions of beetles from overseas. A similar position will arise in 1949. For this and other reasons the Island is particularly interested in the setting up of an International Committee on the control of the Colorado beetle in Europe* and is anxious that success should attend the efforts to control the pest in severely infested countries and to prevent its spread to new areas.

Earlier articles dealing with the control of Colorado beetle in Jersey appeared in the January, 1947, and March, 1948, issues of *Agriculture*

GRASS-FED BEEF

DENYS G. BULLARD
Wisbech, Cambridgeshire

EVERYONE is now talking about beef, and all farmers' discussions on the matter seem to lead to the conclusion that any additional beef we intend to produce will have to be grass-fed. The new schedule of feedingstuff prices, especially the new price for sugar beet pulp, gives no encouragement to the winter feeder. It seems, therefore, that it will be mainly by grass feeding that the calves now being reared under the calf subsidy will be finished for beef. Beef-producing methods begin with the production of the store cattle, and the day on which the grassfield gate is opened is the point at which the art of the grazier really begins This is one of the ancient skills of farming, the fine points of which have much to do with the ultimate financial result.

*WILKINS, V. E. International Scheme for the Control of the Colorado Beetle, *Agriculture* (October, 1948), 307.

Condition of Store Cattle The cattle that do best on grass in most circumstances are those that have been wintered outside on grassland, and have been fed with hay or other home-grown foods, so that they have kept their condition. They are already accustomed to grass as a food, so that they have none of the settling-down troubles to which yarded cattle are subject when first turned out. All winter they have had access to a little greenstuff containing vitamins and minerals, in contrast to the yarded stores which often go woefully short of both. There are fewer ranges of old pasture suitable for outwintering cattle than there were before the war. Store cattle wintered out on leys (and other grassland) are apt to jam up the turf and delay the start of the grazing season proper.

For these reasons most cattle intended for grazing have to be wintered in yards. If it is definitely the intention to finish them on grass they must be in fair condition when turned out, and the winter management must be arranged accordingly. In the North the foods will be roots, oat straw and hay ; in the South more probably barley straw, hay, sugar beet pulp and a little meal. South-country roots and straw are not nutritious enough for cattle, and it will take half the summer, if not all of it, to make up the condition lost in the winter. There is, of course, something in the idea that store cattle, forward in condition and sleek in the coat, will suffer a setback on being turned out. Because that rather forced condition is the wrong condition to aim at, it does not follow that the stores should have "plenty of coat and bone" and not much else. Such bullocks might be the best bargain to *buy*, but their condition is not the one to be aimed at. There are always stories of animals "as poor as crows" being turned out and improving rapidly afterwards. "Dr. Green" is, of course, a wonderful healer. But in all such cases the bullocks have to restore their lost weight before they make any real gain. Grass-fed beef will not be a cheap commodity if it entails the see-saw process of making up the flesh lost in the winter.

Turning Out Turning out can be either gradual—for a few hours a day at first—or final and complete. More experienced people than myself have assured me that the gradual method is a mistake and that cattle once turned out will not be content to eat dry food inside. I have not found it so, provided the cattle are put out *early*—in April or March if there is any keep for them. In the south of England in May there is often a period of dull, very cold weather following rain. In such circumstances cattle newly turned out will scour and look utterly miserable.

Early turning out overcomes this trouble. Even a tiny quantity of protein- and vitamin-rich grass helps to improve the utilization of the roots and dry foods that still remain to be fed in the yards in the last month or so of sleeping in.

It is not always possible, of course, to arrange for cattle to be put out either gradually or early. Some of the best grazings are on marshes where flooding may not have cleared and where growth is always late. These fields are often a long way from the farm buildings.

The Grazing Plan The central problem of feeding cattle on grass is to make full allowance for the falling off in both the quality and the quantity of the grass in the late summer. No grazing plan is sound which is based on the principle of having a fixed head of cattle all summer on a fixed acreage of grass. Most graziers work on the principle of having two groups of cattle, one in more forward condition than the other.

The bigger, more forward cattle are bought late in the previous summer and are well wintered on the farm. They fatten on the first grass, and are gone by late June or early July. The second group is brought on to the grazing farms in spring. These cattle have the second quality pasture until the first group is cleared. Even though the bulk and quality of the grass has declined by that time, the cattle go ahead and do well when the rate of stocking of the land is reduced by about half. They will often make especially good progress in the autumn, when there is a final late growth of fresh grass. It should be possible to finish most of them on the grass. The rest will join the cattle for wintering and early spring feeding the following year. Many graziers also work sheep skilfully into the general plan, the better to control the amount of keep available at the time.

This plan may not be suitable for mixed farming conditions, but the principle of lifting the pressure of grazing in midsummer will have to be followed. One of the best methods of doing this is to transfer some of the younger cattle on to the aftermath of the hay fields.

Change is another essential of any good grazing plan, both for the good of the bullocks and of the pastures.

Old Pastures and Leys for Grazing Cattle The controversy over the relative merits of old pastures and leys is almost spent, but whichever of the two is used for fattening bullocks, it must be good. Farm sale particulars still advertise pastures "which will fatten without cake," though cake feeding on grass has become almost a thing of the past. The phrase is a reminder of the variations that occur in the feeding value of pastures. Heifers will fatten on grass not quite so good as that needed to "finish" steers.

Perhaps the ideal is to feed off the grass just as fast as it grows, and never faster. In practice it is very difficult to keep this balance, and the grass which accumulates in June is often very acceptable in late July. In other words, there has to be some form of cushioning. Leys tend to be less "resilient" in this respect than old pastures, and the grass of the flush period is not so acceptable after a month or two as the carry-over from the old grass. The art of using good leys to feed cattle is therefore more involved than grazing old pasture. Turning out early, using the mowing machine, and having different types of ley, are some of the devices of this art.

Such devices are also useful against the problem of "blowing". This is not the place to enter into any disquisition on the causes of this trouble, but it is generally agreed that it usually follows the grazing of damp, luscious grass and clover. The trouble seems more likely to occur on new grass than on old, and the policy, therefore, must be to graze the leys before they become too lush.

A supply of good water is, of course, a primary necessity, but there is another very elementary need which is often overlooked in ley farming—shelter. Cattle will not feed unless they are comfortable and they will not always be comfortable on an open arable field protected only by a wire fence.

The Age of Grazing Cattle Experienced graziers prefer cattle "with a bit of age about them". These cattle have finished growing as opposed to fattening, and their digestive system is probably better fitted to cope with quantities of easily fermentable grass. The grazier is concerned with buying the animals best suited to his job. It does not necessarily follow that it will pay a general farmer to run his stock to maturity before he attempts to fatten them. Getting that "bit of age" means repeated summerings and winterings and a slow turnover. It is often

1. Refuse deposited by floodwaters between Newborough and Eye.

Photo: *Mirror Features.*

2. Bank of flood refuse on grassland by the River Nene, near Sutton Bridge.

Photo: *B.A. Cooper.*

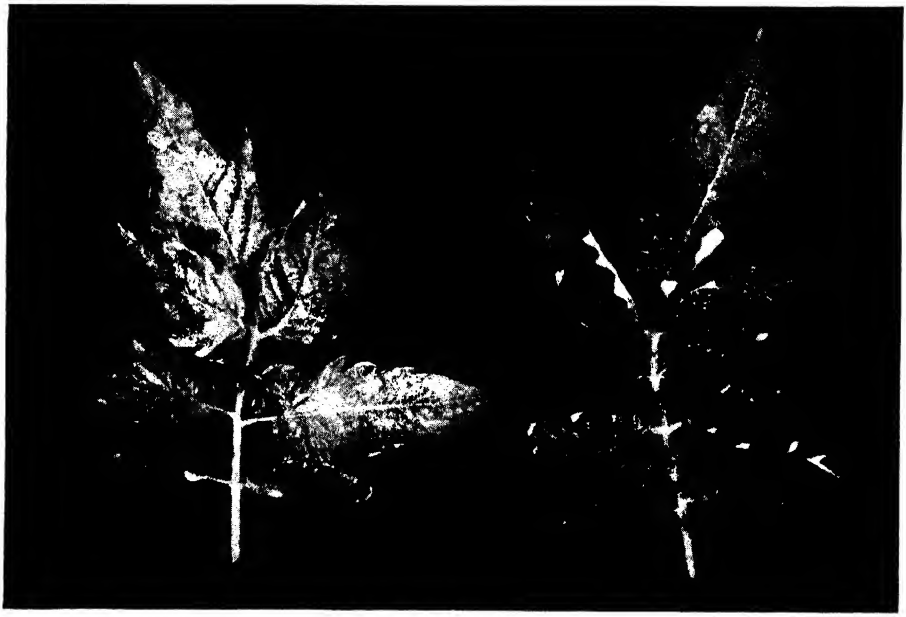
ROOT EELWORM (See pp. 109-14)

3. Potatoes from a clamp spread over the ground near the site of the Crowland breach, in the background.

4. All that remained of a potato clamp near Crowland after the water had subsided. Before the flood, soil from beneath a nearby clamp had given the highest eelworm count so far recorded in this area, cysts at riddling time being found still adhering to the potato tubers.

Photos: *J. O. Page.*

VIRUS DIESEASES OF THE TOMATO (See pp. 119-22)



Tomato Spotted Wilt. The youngest leaves curl inwards and downwards; then small reddish circles and spots develop and coalesce, giving a characteristic metallic bronzing.

Aucuba Mosaic of Tomato. The yellow and green mottling is more pronounced than with Tomato Mosaic and may be quite brilliant.

Photos: *K. M. Smith.*

assumed that the cattle will grow on the by-products of arable farming. But where are the extra by-products to come from to feed an increased cattle population? In fact any increased numbers have got to be given foods—including ley grazings—especially grown for them. A balance must be struck over this age question. It is useless in present circumstances to try to feed cattle that are too young. On the other hand, it should be possible for cattle that have been reared well, and kept going steadily on suitable home-grown foods, to be sold fat off the grass at about three years old.

VIRUS DISEASES OF THE TOMATO

KENNETH M. SMITH, D.Sc., Ph.D., F.R.S.

Plant Virus Research Unit, Molteno Institute, Cambridge University

LIKE the tobacco plant, the tomato is susceptible to infection by a very large number of viruses. Many of these viruses, however, are of academic interest only and do not infect the tomato under ordinary conditions of culture. These will not, therefore, be dealt with in this article, and attention will be confined to those which are, or may become, of economic importance. There are five viruses commonly associated with the tomato plant, of which only two, as far as we know, are insect-borne. In descending order of economic importance, these are the viruses of Tobacco Mosaic and its strains, Tomato Spotted Wilt, Cucumber Mosaic, Tomato Black Ring, and Tomato Bushy Stunt. The symptoms of these diseases and the methods of spread of the viruses will be described first ; next, two common potato viruses sometimes found infecting tomato plants will be dealt with briefly, and finally the methods of control will be treated collectively.

Tobacco (or Tomato) Mosaic One of the properties of viruses generally, which is also a characteristic of living things, is the power to change their form slightly, and plant viruses are no exception. A virus which shows this characteristic very strongly is that of Tobacco (or Tomato) Mosaic, which frequently infests tomatoes under glass. By special methods of selection it is possible to isolate an almost indefinite number of different strains, but in ordinary commercial tomato culture there are about four which commonly occur, and these only will be described.

The parent or type virus gives rise to the well-known Tomato Mosaic in which the leaves, especially the youngest ones, show a mottling of light and dark green. The fruit is normal in appearance. The reduction in yield of individual plants is not great, but in view of the widespread nature of the virus the total loss caused by it and by the next strain must be fairly substantial ; it has been calculated at about 8 per cent. *Aucuba*, or Yellow, Mosaic of tomato is so called because of a fancied resemblance to the variegated laurel (*Aucuba japonica*). It is similar to the Tomato Mosaic, but the mottling of yellow and green (p. iv of art inset) is more pronounced and may be quite brilliant, and the stunting effect on the plant is greater. The ripe fruit is frequently blotched and mottled with yellow.

A third strain of virus which is of much greater economic importance is "Stripe" or "Streak"—sometimes known as "Glasshouse" or "Single Virus" Streak to distinguish it from another Streak disease which is composite in nature and will be described later.

"Stripe" disease causes little or no mottling of the leaves but gives rise to large areas of dead cells (*necrosis*). The name "Stripe" arose originally because of a streak or stripe of dead cells running along the greater part of the stem length. The fruit shows brownish, sunken lesions or pits in the skin, and many of the leaves of an affected plant may die. Under certain conditions this virus may produce, instead of a severe necrotic disease, a mild mottling of the kind associated with the ordinary Mosaic type of virus. The exact reasons for this variation in symptoms are not known, but the variety of tomato plants affected and the degree of hardness of growth may play some part in determining Streak symptoms.

The last strain of Tomato Mosaic virus to be described is the Distorting, or Enation, virus. In severe forms of the disease due to this virus the lamina of the leaf is suppressed so that parts of the plant present a peculiar fern-like appearance. In some cases the undersides of the leaves may develop outgrowths ; these can be cup-like or in ridges, and are known as enations. Another symptom is the occurrence of large numbers of small leaves ending in a corkscrew tendril.

The method of spread of the Tomato Mosaic virus and its strains is the same in each case. As far as we know, insects play no part in their transmission. These viruses are intensely infectious and are spread mainly by mechanical contact between healthy and diseased plants and by contamination of workers' hands and implements. The question of the transmission by seed is a vexed one ; it is possible that the virus is occasionally spread in this manner, but it cannot occur very often.

Tomato Spotted Wilt This virus disease was described for the first time in Australia in 1915 and was first recorded in Britain in 1932. Since then it has spread all over the British Isles and Europe and is probably to be found wherever the tomato plant is grown. It is now one of the most important diseases of the indoor tomato crop, though not so widespread as Tomato Mosaic.

The disease develops about 10–14 days after infection, the first sign being a curling inwards and downwards of the youngest leaves ; then small reddish circles and spots develop and coalesce, giving a characteristic metallic bronzing. If the temperature is high the bronzing rapidly dries out and the leaves die. This stage of the disease is the most dangerous to young plants and recovery is infrequent. In older plants the bronzing stage is followed by a yellowish mosaic mottle on the leaves, which are often distorted. The fruits are poor in quality and frequently show concentric yellow or brown rings.

Tomato Spotted Wilt virus is carried by a thrips. It is the only plant virus known to be spread by this type of insect, and it cannot be transmitted by any other insect species. There is no evidence of seed transmission.

Cucumber Mosaic Virus From being the cause of a mosaic disease mainly on cucumbers, this aphis-transmitted virus has now spread to a very wide range of perennial flowering plants such as dahlias, delphiniums, and chrysanthemums. In consequence, there is nearly always a source of virus in the vicinity of cucumbers and tomatoes, and the chief reason why tomatoes are not more frequently infected with this virus is probably that the plant, except in its younger stages, is not a

favourite host plant of the aphis vector of the virus. Symptoms of this virus on tomatoes take the form of a narrowing of the leaf blades, though the very extreme form of "fern leaf" symptom is not common in this country; there is usually also a faint mottling of the leaves. This disease is not usually of much importance in the glasshouse but sometimes causes serious losses in tomatoes grown out-of-doors.

Tomato Black Ring This is a comparatively new disease and was described for the first time in 1944; in some ways the symptoms resemble those of Spotted Wilt but the two diseases can be differentiated. The first sign of infection is the appearance of numerous small black rings on the leaves, but there is none of the metallic bronzing which is usually present with Spotted Wilt. The rings spread and coalesce, killing out the growing point, and young tomato plants are often killed by a general necrosis.

Tomato Black Ring is a serious disease, as far as young plants are concerned, but if they survive the initial stage they grow away from the necrotic symptoms and show only faint concentric rings on the leaves. Like the viruses of Cucumber Mosaic and Spotted Wilt, this virus attacks a great many different plants, a large number of which show no symptoms. The method of spread of the Black Ring virus is not known; it does not appear to be carried by any of the common insects associated with the tomato plant. In this country the disease seems to be confined to East Anglia, but a similar disease has recently been recorded in India.

Tomato Bushy Stunt This virus disease was first recorded in 1935 on some tomato plants from the west of England, and subsequently in one or two other centres. Since that time it has appeared only once, but it is mentioned here because of its great scientific interest and because it may turn up again at any time and cause losses to tomato growers.

Like the Black Ring disease, Tomato Bushy Stunt is most severe on the young plants. The first sign of infection is a slight yellow mottling of the young leaves, and the upward growth of the plant ceases. Frequently the affected plants fall over, owing to the development of a necrotic lesion at, or about, soil level. There is a tendency for the leaves to show a yellowish or purplish colouring with some ring formation. Older plants may be bushy and stunted because of the development of lateral growth. There is no information on the method of natural spread of this virus.

Double (or Mixed) Virus Streak This disease arises when tomato plants already infected with Tomato Mosaic also become infected with the Potato Mottle virus, known as Potato Virus X. Double Virus Streak is an important disease in the U.S.A., where tomatoes and potatoes are grown in close proximity, but in Britain it does not often occur since tomatoes are largely a glasshouse crop. Because Potato Virus X spreads, as far as we know, only by mechanical contact between diseased and healthy plants, there is very little opportunity for the potato virus to infect tomatoes, though the virus might be carried to tomatoes on the hands of workers who had recently handled potato plants. When it does occur this type of Streak is similar to the Single Virus Streak but may be rather more severe. The first sign of infection is the appearance of numerous dark spots or lesions on the top leaves, and similar longitudinal lesions or streaks develop on the petioles and stem. If the growing point is not killed, the plant may survive, but it remains stunted, spindly, and unthrifty. The fruit is usually marked with irregular sunken patches.

One other potato virus is occasionally found infecting tomato plants, especially those grown out-of-doors. This is an aphis-transmitted virus known as Potato Virus Y, and the disease caused in the tomato plant is very mild. Leaves of affected plants show a faint mottling caused by a banding of the veins with a deeper green colour. The symptoms are never strongly marked, and as the plant grows they may disappear altogether.

Control of Tomato Virus Diseases Some of the virus diseases of tomatoes described in this article are most common in mixed houses where ornamental plants are grown near the tomatoes. This applies especially to the Spotted Wilt and Cucumber Mosaic viruses. As far as Spotted Wilt virus is concerned, arum lilies, chrysanthemums, and dahlias are frequently infected, whilst chrysanthemums, dahlias and delphiniums commonly harbour the Cucumber Mosaic virus. It is sometimes difficult to tell from inspection alone whether some of these ornamental plants are actually infected, since symptoms may be very mild and transient. Wherever possible, therefore, tomatoes should not be grown in the same house as ornamental plants.

It should be remembered, also, that the Spotted Wilt and Cucumber Mosaic viruses are insect-borne and that they will not spread in the absence of their respective vectors—the thrips for Spotted Wilt and the aphis for Cucumber Mosaic. Both these insects can be kept under control by regular nicotine fumigation.

Viruses of the Tomato Mosaic type are not insect-transmitted, and control measures are therefore rather different. The first and most important measure is to eliminate the sources of the Mosaic infection, which may be: (1) the seed, (2) cigarettes and pipe tobacco, or (3) portions of diseased plants left in the soil from the previous year.

It has already been pointed out that the question of seed transmission of Tomato Mosaic has not been answered satisfactorily. To be on the safe side, therefore, it is always better to save seed from Mosaic-free plants. In potting the young tomato plants it is very important to be on the look-out for any suspicious mottling of the leaves; plants showing these symptoms should be destroyed and their near neighbours put on one side for re-examination in about two weeks' time. Since this type of virus is so infectious, one or two plants with Mosaic are sufficient to infect a house of several thousand because the infection is carried over from plant to plant during routine cultural operations.

The Tomato Mosaic virus is very stable and heat-resistant, and consequently is usually present in an infectious state in cigarettes and pipe tobacco. It is undesirable, therefore, to smoke whilst handling tomato plants, and the hands should be washed frequently with soap and water. Because this virus is so stable and resistant, it will remain infectious in pieces of plant tissue for long periods, and may even persist from one season to the next. Whilst this is not considered a very important source of infection, it is one which should be borne in mind.

Correction

Yarded Beef Production (May, 1949), p. 77, para. 1, line 8.
For "£45" read "£15".

CLAY MARLING: MECHANIZED METHODS

R. B. FERRO, N.D.A., *County Agricultural Officer, Yorkshire (East Riding)*
and
A. C. MIDDLETON, B.SC. (AGRIC.), Q.A.L.A.S., *Surrey Agricultural Executive Committee*

WHEN the East Riding War Agricultural Executive Committee was considering means of increasing the output of the arable land in the Riding, they believed that a revival of clay marling could be of considerable assistance on some of the sand farms*. It was clear that an alternative to the cheap and plentiful supply of labour which had been used for the work in the past would have to be devised and, in the spring of 1944, discussions with the Ministry of Agriculture were concluded whereby the East Riding Committee was asked to conduct an investigation into the costs and organization of mechanized methods of clay marling. Arrangements were made for the work to begin in September, 1944, and conclude in September, 1946. Some of the work was carried out directly by the Committee and some on their behalf by public works contractors.

Blowing on Sand Lands of the East Riding There is a considerable area of light sand land in the East Riding, of which about 40,000 acres would benefit from clay marling. The sands are in two main areas—one in the Vale of York, and the other in the Vale of Pickering. They lie immediately to the south-west and to the north of the great crescent of chalkland which is the Yorkshire Wolds. Between the sands and the Wolds there are deposits of Speeton, Lias and Keuper clays, which, in earlier days, were dug out and spread on the light blowing sands. Latterly, the practice died out, owing to the rising costs of labour.

When there is a high wind, many of the unmarled sands blow so easily that crops in the seedling stage may be torn from the soil or so severely damaged that resowing is necessary. Inevitably, costs of production are increased and yields are reduced through late development, the significance of which needs no emphasis when those crops are, in the main, sugar beet and carrots. Further, ditches very soon become choked with blown sand. The prevention of blowing is not the only benefit to be derived from marling; the soil texture is improved, and a wider range of crops can be grown.

In addition to the condition of the surface soil, other important factors affecting blowing are the contour of the land, the presence or absence of shelter belts, woods and field hedges, the types of cultivation and the relationship between prevailing winds and the season of the year. Often only parts of a field blow badly, e.g., the tops of small undulations in an otherwise comparatively flat field, and of the 1,662 acres marled during the investigation, 46.9 per cent comprised small parcels of land of less than 5 acres, and a further 29.1 per cent were fields or parts of fields of between 5 and 10 acres.

In planning the mechanical equipment for the investigation, it was clearly necessary to decide a suitable rate of application of the marl. Comparison of a good carrot-growing soil with one of the blowing sands suggested 80-100 tons per acre. After inspecting fields dressed at this rate, growers considered the quantity insufficient, and the rate of application was raised to 150 tons per acre. Dressings above or below this quantity could be applied at the special request of the person for whom the work was being done. By the time the investigation was completed, 248,221 tons of marl had been

* MIDDLETON, A. C. Clay Marling: Some Historical Notes. *Agriculture* (May, 1949), 80

applied to 1,662 acres at an average rate of 149.3 tons per acre. Much more information is required about the effects of different rates of application, and so trials were laid down in the county with rates varying from 50 to 200 tons per acre.

The complete job of clay marling may be divided into three main sections: (a) selection and operation of the pit; (b) transporting the marl from the pit to the field; (c) spreading the marl on the land.

Pit Operation It is clear that a pit should be opened only where there is an adequate supply of clay either at or very near the surface. A well-sited pit should involve the minimum removal of overburden, provide an adequate quantity of marl, be free from serious flooding and so placed that there is short and good access to a hard road, preferably downhill, to facilitate the departure of laden transport. When the site has been determined, negotiations must be completed with owners and occupiers for rights of way to the land which is to be marled. Moreover, if new pits are opened, the effect of the Town and Country Planning Act, 1947, should be considered in relation to possible development charges where the marl is to be sold for use on land not "held with" the site of the pit, and in relation to the general planning regulations.

In some of the twenty-nine pits opened, flooding was a serious menace and pumping became necessary. Careful excavation can help to overcome the difficulty by leaving barriers of clay in the form of bulkheads to confine the water. If the marl is excavated in a dry, friable condition, it is much easier to spread in the field.

At first, when very wet weather was experienced, an attempt was made to keep the work going whatever the conditions. This soon proved to be faulty practice and, subsequently, operations were stopped as soon as the weather worsened. It was found that, by so doing, work could be re-started with the least delay.

The laying of chestnut pale and sleeper tracks can improve access to and departure from the pit and thus avoid many delays due to rutted roads. An observant and conscientious pit foreman can foresee trouble and avoid delays.

DRAG-LINE AND FACE-SHOVEL In all but one of the pits excavation was from land level downwards, for which drag-line excavators were employed. A 32-feet jib on the drag-lines was generally satisfactory to deal with the depth of clay available and, working with a 12-cu. feet bucket in favourable conditions, a day's output was 250-275 tons per machine. 300 tons per day was often exceeded, and the record daily output was 485 tons.

In one exceptionally good pit, at West Heslerton, where the overburden was negligible and the clay was over 40 feet deep, terrace working was possible and allowed two drag-line excavators to work simultaneously at different levels. For safety reasons two machines should not work one immediately above the other. Although 28,000 tons of marl were obtained from this pit, there was the minimum loss of land and spoliation of the country.

At one pit, at Hotham, the clay outcropped on a fairly steep hillside and a face-shovel excavator could be used. Its output compared favourably with that of the drag-lines. The difficulty of wet clay adhering to the buckets was overcome by fitting hardwood linings, and it was necessary to elongate the catch on the release gear of the face-shovel, which otherwise became choked with clay.

Multi-bucket Excavator It was hoped also to investigate the operation of a multi-bucket excavator but, owing to difficulties of delivery in 1945 and the early part of 1946, only a few days' work was obtained. This was unfortunate, because experience of the machine in brickyards suggested that it would be useful in clay marling, provided the deposit gave the equipment adequate scope.

Scrapers, Cable-drag Scrapers, Slurry Mills Scrapers now used on opencast coal sites, aerodrome construction and other large earth-moving contracts, were not employed: first, because of the difficulty of delivery at that time; second, because their size would introduce great difficulties in travelling on farm roads; and third, because they could not deposit the marl in a carpet less than 2 inches thick. Such a dressing would be equivalent to a rate of approximately 330 tons per acre, or more than double the usual application.

Excavation with cable-drag scrapers was also considered, but they were not employed as their use is limited to operations where the pit is in the field to be marled, and these circumstances rarely occurred during the investigation.

The possibility of emulsifying the clay in a slurry mill and pumping it on to the land was also reviewed, but this is not possible where the marl is to be transported any distance. Furthermore, adequate water supplies were not available, and the stones which occur in so many of the East Riding marls would have interfered seriously with the process.

Transport:
Tractor-trailers Where the pit is only a few hundred yards from the land which is to be marled, the usual type of agricultural tractor and trailer may be used for transport, especially if the farmer is to carry out the work during slack times. They are not suitable for large-scale operations where the marl has to be carried and then dumped in small heaps preparatory to spreading. A sticky clay cannot be spread from a trailer with the same facility as, say, farmyard manure. Moreover, a "train" of more than one trailer is unwieldy to handle.

"Dobbin" Wagons In 1944, when tipping-lorries were very scarce, it was decided to use tractors and "Dobbin" wagons for transport purposes. The "Dobbin" wagon consists of a side-tipping tub and chassis mounted on two pneumatic-tyred wheels. It can be drawn singly or coupled in trains of two or more. They carried a larger load than farm trailers, 30-35 cwt. each, or 4½ tons in a train of three hauled by a single tractor. Industrial tractors were chosen instead of agricultural tractors to haul the wagons, because of their higher road speeds. Where, however, travel is wholly or mainly on farm roads or tracks, any of the usual agricultural tractors could be used and, of course, since 1944 there have been many developments in tractor design to give higher road speeds.

Tipping Lorries Later, in view of the restrictions imposed by the Road Traffic Act, 1930, upon the haulage of laden trailers and their effect on contracts involving road travel, the "Dobbin" wagon organization was replaced by 3-, 4- and 5-ton tipping lorries. Their operating costs were higher than those of the tractor-"Dobbin" trains.

Dumpers On a few contracts, dumpers were engaged as part of the transport service. Although the most modern design allows them to be used on the highway and they can carry 1-4 tons of material, it appears that for marling they are best suited to work near the pit. The maximum distance appears to be ¼-½ mile. They achieved high speeds under load, but

a weakness which they share with the tipping lorries is that the load of marl is dumped in a single large heap, up to 4 tons in weight, compared with the larger number of small heaps, of, say, 1½ tons each, when the side-tipping "Dobbins" are used.

The choice of route from pit to field demands the most careful consideration, taking full account of the type of vehicle, its weight laden and the travelling conditions. It may, of course, require revision according to changes in the weather during the progress of the work, and the shortest cross-country route is not always the quickest.

Spreading Marl in the Field Spreading the marl on the land presents greater problems than either excavation or transport, because not only must the work be carried out at a reasonable cost, but the clay must be left in a state in which it may become incorporated uniformly with the soil. A friable marl such as Keuper is easier to handle and spread than a tenacious Speeton clay, and, with the latter, weathering on the field before spreading can be of considerable help.

The marl was dumped from the "Dobbin" wagons so that an area of land having a radius of not more than 10-12 feet could be dealt with from each heap. Two men were enough to spread such a heap; if more men were employed they tended to get in each other's way. In very favourable circumstances eight good men could spread 200 tons in an eight-hour day; that is, an average of 3⅛ tons per man per hour, but the average output for all manual spreading was not more than about 1¼-1½ tons per man per hour. At first, Italian prisoners of war and later Germans were employed, but however carefully the work was planned, it proved to be very monotonous.

BY MACHINE Various combinations of tractor, cultivator and tool-bar equipment were tried to replace hand labour, but none proved really satisfactory, nor were ordinary angledozers and bulldozers any more successful, as the tracks tended to squash the clay into the surface soil. Little more success attended these methods when the marl was to be spread on a hay or corn stubble rather than broken land, and it was clear that some newly designed equipment would be necessary if spreading were to be carried out efficiently and to the required standard.

In 1945 one of the contractors introduced an Austin-Weston Grader, an elaborate machine of American manufacture. Its chief virtues were its hydraulically-operated angledozer blade and its ability to straddle the marl heaps, which could then be split and spread. Although the machine performed satisfactory work, operating costs were comparatively high and it is unlikely that it would be suitable for the future, except on very extensive operations.

It was found that transport and spreading accounted for about three-quarters of the cost of the complete operation. If a transport unit could be fitted with a spreading mechanism, a considerable saving would be made. To this end the Howard-Fowler Marl-Clay Spreader was devised. This is tractor-towed and consists of a steel container of 5-ton capacity mounted on the back axle and rear wheels assembly of a rubber-tyred tractor. 1½-inch angle-iron slats, spaced 12-14 inches apart upon two parallel endless chains, move from the front to the rear along the bottom of the hopper-shaped container. At the rear there is a slatted gate oscillating vertically to control the passage of the marl on to fast-revolving blades which disintegrate the clay and spread it evenly over the land. The spreading mechanism is driven from the power take-off of the towing tractor and, if necessary, the back axle of the latter can be connected to the axle of the spreader, thus converting the outfit into a four-wheel drive vehicle.

The machine was designed to apply 75 tons or 150 tons per acre, although sprockets could be fitted to give intermediate rates. It was found preferable to give two applications at 75 tons per acre, rather than a single dressing of 150 tons per acre.

The general performance was very satisfactory and, altogether, proved most promising.

Costs and Methods Compared The investigation has shown that clay marling can be undertaken satisfactorily with mechanized equipment. The economic aspects are a matter for each individual owner or occupier, according to his particular circumstances. The varying costs and man-power requirements of the methods used during the investigation are summarized in the following Table. They are calculated from the actual working records and thus reflect the wage rates and costs of mechanical maintenance and operation ruling from September, 1944, to October, 1946. Italian and German prisoner of war labour and male and female civilian labour were employed for varying periods.

Analysed Costs of Each Operation in Pence per Ton (in bold type) and in Man-hours per Ton (in italics)

	Committee			Contractor A	Contractor C	Contractor C
EXCAVATION:	**7.0** *0.07*	**7.0** *0.07*	**7.0** *0.07*	**13.5** *0.06*	**11 5** *0.06*	**11.5** *0.06*
TRANSPORT:						
Tractors/Dobbins	**10.1** *0.43*					
3-ton Tippers		**25.4** *0.38*				
4-ton Tippers					**12.9** *0.12*	
5-ton Tippers				**13.2** *0.13*		
SPREADING:						
By hand	**15.3** *0.75*	**15.3** *0.75*			**14.2** *0.69*	
Grader				**12.1** *0.03*		
Marl-Spreader			**31.3** *0.72*			**4.8** 0.07
Total Cost	**32.4**	**47.7**	**38.3**	**38.8**	**38.6**	**16.3**
Total Man-hours	*1.25*	*1.20*	*0.79*	*0.22*	*0.87*	*0.13*

The time taken for excavation remained fairly constant throughout the investigation, and the cost of 11½d. to 1s. 1½d. a ton incurred by the contractors is a better figure to take than the 7d. per ton cost to the Committee. The low wage rates for prisoner of war labour in 1944 and 1945 affected the latter figure.

Tractors and "Dobbins" provided a cheap and satisfactory means of transport within their strictly limited use, and compared favourably with the cost of the tipping-lorries operated by the contractors. The high cost of running the Committee's 3-ton tippers was due very largely to difficulties encountered in having to engage unskilled drivers—a complication that did not beset the contractors.

Mechanical spreading reduced the man-hour requirements, but with the Austin-Weston Grader the cost remained about the same, owing to high overhead charges. The combination of transport and spreading with the Howard-Fowler Marl-Clay Spreader reduced both cost and man-power and, whilst the charge of 31.3d. per ton is unduly high (it included all the development work with the prototype), the cost of 4.8d. per ton is lower than would normally be expected and was achieved on a small and very favourably situated contract.

The varying labour and machinery requirements of the component operations of excavation, transport and spreading have had a compensating effect on one another, so that the total cost of each method shows only slight variation from 32.4d. to 38.8d. per ton. This comparison excludes the cost of 47.7d. per ton, which was unduly high owing to the exceptional transport costs already mentioned, and the 16.3d. per ton, which was exceptionally low because of the very favourable operating conditions.

Charges to Participants in the Scheme The seventy-seven participants in the scheme, for whom 108 contracts were completed, shared the total cost of the work in each year on the basis of a "pool price" per ton of marl, which was subject to a Treasury contribution towards the cost of the investigation. In the first year, the pool price was 2s. 8¼d. per ton, and in the second year 3s. 9½d. per ton. Thus, at 150 tons per acre, the gross cost was £20 3s. 1½d. per acre in the first year and £28 8s. 9d. per acre in the second year. Where the marl was purchased from one landowner for application to the land of another, the actual cost was charged in addition to the pool price.

The Future It is considered that any future large-scale contract operations should be confined to the most favourable eight or nine months of the year, and, by making full use of combined transport and spreading equipment, it is probable that the total cost would be between 2s. and 3s. per ton or approximately £15 to £20 per acre at 150-ton rate of application. This assessment is based on the wage rates and costs of mechanical operation last autumn.

It should be emphasized that this investigation was confined to the East Riding of Yorkshire and that conditions in other counties may well need other methods and modifications in the types of equipment. There is no doubt, however, that the age-old practice of clay marling can be performed efficiently with modern mechanical equipment, and it is also certain that this method of land improvement has a part to play in increasing the productivity of many of our light sandy soils.

FARMING IN THE WEST OF ENGLAND will be the theme of next month's issue of *Agriculture* in view of the venue of the Royal Show at Shrewsbury, July 5-8.

Ministry of Agriculture Exhibit, including practical demonstrations, will be on **Stand No. 26, Block H.**

Milk Production in Cornwall, Devon and Dorset

The statement that investigations into the economics of milk production are dangerous because they direct attention to only one aspect of mixed farming economy, if valid in some areas, scarcely applies to the investigation which has resulted in Farmers' Report No. 55, published by the Department of Economics, University of Bristol. The report analyses the costs, returns and margins of 74 milk production enterprises in parts of Cornwall, Devon and Dorset. The danger must be the difficulty of securing in such a relatively small number of holdings a truly representative cross-section of the very large number of farms (8,000 in Cornwall alone) on which milk is a major source of income.

In such a case statistical results tend to be influenced by exceptional circumstances, like the 3 out of 10 north Dorset herds in which above-average efficiency has helped to make the margin per cow £11 higher than in the west Cornwall group. Lest the latter takes excessive comfort from this, let it be said that producers who lend their businesses to such surveys tend to be those who at least strive for efficiency to the best of their ability in the conditions under which they farm. Nor is there much comfort for those of us who may still cherish an ambition to set up in business. The capital investment on stock and purely dairy equipment, excluding of course the general farm equipment, is high.

According to this report, which covers the 1947-48 milk production year (incidentally an exceptionally favourable one), feedingstuffs produced on the farms accounted for 25 per cent of the gross cost of the milk. This emphasizes the wisdom of the decision to extend the survey to cover such costs, and the importance of advisory officers interesting themselves in farm planning so that through maximum production the minimum area can serve this need.

The report confirms trends which the interested observer of milk production from the outside would expect to see :

(a) Yield per cow has increased mainly in herds in the lower yield groups. It was, however, a favourable year.
(b) As a result the cost per gallon was lower than in 1946–47, although the cost per cow was slightly higher.
(c) Herds averaging over 800 gallons were nearly four times as profitable, at £47 8s. per cow, as those averaging less than 500 gallons. There are 7 herds in the former group and 12, including 2 giving less than 400 gallons, in the latter.
(d) Herds producing graded (T.T.) milk were more profitable than those producing non-graded milk—presumably a measure of greater interest, and, therefore, efficiency.

The farmer can gain much from an intelligent study of this report. The advisory officer can gain more and is in a position to pass the lessons on to, at any rate, a proportion of the many who produce milk in these parts of the South West Province.

Keeping Farm Machines in Good Condition

"If starvation is avoided over vast areas of the world, it will be due largely to modern farm machines in the hands of capable farmers." So say the authors, Arthur W. Turner and Elmer J. Johnson in the Preface to their recent *Machines for the Farm, Ranch, and Plantation,** a book designed to promote the efficiency of all kinds of farm machines by a basic understanding of the needs of maintenance and thorough servicing. Ever since the marriage of implement to power, with the harnessing of the first ox to the wooden plough, farm productivity has gone steadily forward, always bringing with it new problems for the farmer, the farm engineer and

*McGraw-Hill 36s.

the economist to solve. The degree of mechanization depends, of course, on the size and nature of the farm, the capital available and the economic return which it is estimated can be secured, and every farmer will weigh these cardinal factors carefully before translating his cash into fixed capital. But having taken the plunge, it is in his own interests, no less than in the interests of the world need for more food, that the efficiency of his small tractor, windrower or combine harvester, as the case may be, should not be impaired by neglect.

Although addressed to the American farmer, this profusely illustrated book would be a valuable adjunct and another farming "tool" to farmers, farm students and advisers in this country.

Rations for Livestock Apart from the addition of the extended and bonus schemes for pigs and poultry and a variation in the farrowing sow allowance, the ration scales for livestock which came into force on May 1 are the same as those for last summer. However, the farrowing sow allowance will be increased on July 1, and rations for pigs will be increased on September 1.

Pigs and Poultry. Basic rations for pigs and poultry will be provided at the summer scale of 1 cwt. per pig and 1½ cwt. per 20 poultry for each month up to and including August, in respect of one-fifth of the numbers registered as being kept on the holding in 1939 or 1940, less a deduction at the rate of 1 pig for every 64 acres and 3 birds for every 16 acres of the holding. Allowances for sound poultry breeding stock (based on the autumn, 1948, count) and for pedigree pigs, additional to basic rations, also remain unchanged. The arrangements made under the new extended scheme for pigs and poultry, which was introduced last October and reopened recently to new applicants, will continue. The higher summer rate of rations for poultry under this scheme is dependent on an increase of at least 50 per cent of birds over the specified winter numbers.

On September 1 basic rations for pigs will be increased by about one-eighth, subject to the full number of pigs for which rations are issued being kept. Holders of combined registrations for pigs and poultry will benefit on the understanding that increased numbers of pigs are kept. Under the extended scheme, there will on the same date be an increase in specified numbers of pigs, related to the size of the holding, of approximately 50 per cent with a modification of the present limitation on the issue of rations for sows. Those who wish to transfer from the basic to the extended scheme will be able to do so before September 1.

Farrowing Sow Allowances. The allowances for farrowing sows and gilts are now at a standard rate of 8 cwt. The rate will be increased to 9 cwt. on July 1. C.A.E.C.s have discretion to grant farrowing allowances to applicants whose holdings *exceed* 1 *acre* who do not normally draw rations for pigs. The Committee must be satisfied that the pig-keeper has facilities for successfully breeding pigs and the means of providing food for the sow between farrowings. And the number of farrowing allowances will not exceed those which would be applicable under the new extended scheme.

Bonus Rations are available (on application to the C.A.E.C.) based on pigmeat or eggs sold through approved channels to the Ministry of Food during the period January to April. The bonus rates will be 1 cwt. per 8 score (160 lb.) of pigmeat delivered during the four months January to April and 1 cwt. per 160 dozen gradable hen and duck eggs delivered to a packing station during the 17 weeks ended on April 27, 1949.

From September 1 the bonus ration for pigs will be 3 cwt. per 160 lb. of pigmeat delivered during the previous four months.

COWS AND CALVES. Rations on the same scale as last summer are now available, on application to County Agricultural Executive Committees, for dairy herds with relatively high average yields, and for calves under 6 months old. Supplementary allowances may again be made if poor growth of grass is affecting milk output, or for individual high yielding cows in herds with an average yield too low to qualify for rations, or for dry cows and calving heifers requiring some concentrates before calving. A separate announcement will be made later about rations for cows and heifers calving in the autumn.

OTHER ANIMALS. Allowances for horses, goats and other animals will be obtainable on application under conditions similar to those in operation last summer.

SALES OF SEED OATS, SEED BEANS AND SEED PEAS OF FEEDING VARIETIES

Arrangements are again being made, as last year, for feedingstuffs coupons to be supplied, on application, to growers of oats and of beans and peas of feeding varieties from the 1949 harvest who, by selling these crops for seed, have left themselves short of feedingstuffs for the livestock on their holdings. The arrangements do not apply to beans and peas of varieties grown for human consumption or to oats, beans and peas sold for feeding or milling purposes.

Applications for coupons under these arrangements must be accompanied by a certificate from the buyer that the seed crops have been delivered after July 31, 1949, and should be made before May 31, 1950, to the County Agricultural Executive Committees in England and Wales.

Nature Month by Month: June

In "leafy June" natural life reaches its zenith. The trees of the wood are full-foliaged; the hedges gay with dog-roses; the lanes with campion, red and white, and here and there some late bluebells. In the meadows there are celandine and speedwell, daisies and many other flowers, and by the river the massed gold of the kingcups seems to blaze in the summer sun.

Among the limes the drone of innumerable insects is like a sustained organ note, and every bush and yard of turf has its teeming insect life. In a ride in the wood a party of black and orange sexton-beetles are busily interring a dead shrew. The sandy waste beyond the wood has many fast-moving tiger-beetles, quartering the ground in search of prey, now and then taking wing, green as emeralds.

The young thrushes of the first brood have flown, and many of the parent birds are occupied with second families. Even the latest arriving migrants are nesting now. On a thorn bush a butcher-bird's "larder" is mercilessly displayed. Perched on a post in the garden is a trim spotted flycatcher; now and then it darts out in pursuit of some winged insect and returns quickly to its look-out. In a clearing of the wood there lie, like two carelessly thrown pebbles, the eggs of a nightjar.

Following a heavy rain and a spate some early peal are up. They will not move much by day, but in late evening or after dark they may rise to a fly or be lured by a spinning minnow. Some half dozen of them lie in the tail of a pool; one of them turns lazily with a flash of silvery flank. A cock dipper bobs and bows from a boulder in midstream, his white bib conspicuous against the sombre shades of the rest of his plumage.

The Moor is drier, now, although some of the mires need care in circumventing. There is one I know that has across it a curiously directed, submerged granite pathway. As a small boy I was shown the trick of it—five

yards half-right, ten straight ahead, three half-right again and then another three half-left. A careless foot on either side at any stage of the journey, and one is in a mess.

Summer is here and the sun rides high. At noon, one is grateful for a little shade. Soon the longest day will have come and gone, and the evenings will be drawing in again.

F.H.L.

AGRICULTURAL STATISTICS ENGLAND AND WALES

June 4, 1948, Agricultural Returns (Final Results)

CROPS AND GRASS

(thousand acres)

Description	*1939*	*1947*	*1948*
Wheat	1,683	2,075	2,188
Barley	910	1,879	1,897
Oats	1,358	1,963	1,992
Mixed Corn	83	489	588
Rye, for threshing	(c)	32	57
Rye, for green fodder	(c)	4	5
Total Rye	**16**	**35**	**62**
Beans, for stock feeding	133	81	80
Peas, for stock feeding	37	36	45
Potatoes, first earlies	56	167	222
Potatoes, main crop and second earlies	398	774	895
Total Potatoes	**454**	**941**	**1,117**
Turnips and Swedes for stock feeding	396(d)	401	355
Mangolds	210	264	272
Sugar Beet	337	386	405
Rape	53	115	104
Cabbage, Kale, Savoys and Kohlrabi, for stock feeding	94	165	189
Vetches	49	27	38
Lucerne	32	(e)	(e)
Mustard, for seed	24	36	17
Mustard, for fodder or ploughing in	24	25	21
Flax, for linseed	4	52	86
Flax, for fibre			14
Hops	19	22	23
Orchards with crops, fallow, or grass below the trees	236	260	255
Orchards with small fruit below the trees	18	11	12
Small fruit, not under orchard trees	29	25	28
Vegetables for human consumption (excluding potatoes), Crops under glass, and Flowers	275	554	583
All other crops	32	50	45
Bare fallow	355	497	238
TOTAL OF CROPS AND FALLOW (TILLAGE)	**6,862**	**10,388**	**10,652**
Clover, Sainfoin and Temporary Grasses for mowing	1,304	2,273	2,079
Clover, Sainfoin and Temporary Grasses for grazing	768	1,331	1,378
Total Temporary Grass	**2,072**	**3,604**	**3,457**
TOTAL ARABLE LAND	**8,935**	**13,992**	**14,109**
Permanent Grass for mowing	4,612	2,597	2,655
Permanent Grass for grazing	11,097	7,651	7,608
Total Permanent Grass	**15,709**	**10,248**	**10,263**
Land temporarily out of use through flooding (a)	—	87	—
TOTAL ACREAGE OF CROPS AND GRASS (b)	**24,643**	**24,327**	**24,373**

contd.

CROPS AND GRASS (*thousand acres*) *contd.*

Description	1939	1947	1948
Rough Grazing—Sole rights ..	4,179	4,133	4,118
,, ,, —Common ..	1,361	1,436	1,436 (f)
Total Rough Grazing ..	**5,541**	**5,569**	**5,554**

(a) Special question asked only in 1947.
(b) Excludes rough grazings.
(c) Not separately returned.
(d) Includes Turnips and Swedes for human consumption.
(e) Included under "Temporary Grass".
(f) Provisional.

SMALL FRUIT, VEGETABLES AND FLOWERS

(*thousand acres*)

Description	1939	1947	1948
Strawberries ..	18.7	13.0	16.1
Raspberries ..	4.1	2.4	2.8
Currants, Black ..	10.4	11.3	12.4
Currants, Red and White ..	2.3	1.5	1.5
Gooseberries ..	9.1	6.0	6.1
Loganberries and cultivated Blackberries ..	2.5	1.1	1.1
TOTAL SMALL FRUIT ..	**47.2**	**35.3**	**39.9**
Brussels Sprouts ..	38.0	50.7	54.7
Remaining Spring Cabbage (planted in 1947) ..	44.1	12.7	12.2
Summer Cabbage ..		10.9	11.4
Autumn Cabbage ..		7.7	8.5
Winter Cabbage ..		15.8	17.2
Autumn Savoys ..		6.7	6.2
Winter Savoys ..		21.2	17.0
Kale and Sprouting Broccoli ..		2.7	2.5
Cauliflower or Broccoli (Heading) ..	18.9	32.4	34.4
Carrots ..	16.1	33.2	34.6
Parsnips ..	(a)	5.3	8.9
Turnips and Swedes ..	(a)	12.7	9.2
Beetroot ..	(a)	10.9	11.1
Onions ..	1.7	11.3	14.8
Beans, Broad ..	17.8	3.9	6.2
Beans, Runner and French ..		12.3	12.8
Peas, Green for Market ..	60.6	51.1	54.4
Peas, Green for Canning ..	28.0	20.1	22.8
Peas, Harvested Dry ..		170.3	180.2
Asparagus ..	2.6	1.6	1.7
Celery ..	6.7	3.4	6.1
Lettuce ..	5.9	8.4	7.5
Rhubarb ..	7.2	8.0	8.5
Tomatoes (growing in the open) ..	0.2	2.8	3.2
Other vegetables growing in the open ..	(a)	15.1	14.4
All Crops growing in Glasshouses ..	3.3	3.7	3.7
All Crops growing in Frames ..		0.4	0.5
TOTAL VEGETABLES (excluding Potatoes) ..	**251.0**	**538.5**	**564.8**
Hardy Nursery Stock ..	10.5	7.9	8.3
All Bulb Flowers, not under glass ..	7.7	3.4	4.0
Other Flowers not under glass ..	5.8	4.7	5.7
TOTAL FLOWERS ..	**24.0**	**16.0**	**18.0**

(a) Not returned.

LIVESTOCK

(*thousand head*)

Description	1939	1947	1948
Cows and heifers in milk ..	2,255	2,250	2,278
Cows in calf but not in milk ..	392	513	516
Total ..	**2,646**	**2,764**	**2,794**
Heifers in calf, with first calf ..	459	661	709
Bulls for service ..	91	106	104
Bulls (inc. bull calves) being reared for service ..	43	44	45

contd.

AGRICULTURAL STATISTICS: ENGLAND AND WALES

LIVESTOCK (*thousand head*) *contd.*

Description	*1939*	*1947*	*1948*
Other Cattle two years old and over:			
Male (Steers)	(a)	449	438
Female	(a)	653	628
Total	**944**	**1,102**	**1,066**
Other Cattle one year old and under two:			
Male (Steers)	(a)	292	276
Female	(a)	933	889
Total	**1,346**	**1,225**	**1,165**
Other Cattle under one year old (excluding bull calves being reared for service):			
Male (Steers)	(a)	279	356
Female	(a)	995	1,102
Total	**1,242**	**1,274**	**1,458**
TOTAL CATTLE	**6,770**	**7,175**	**7,340**
Sheep one year old and over:			
Rams for service	205	123	119
Ewes for breeding	7,160	4,087	4,317
Two-tooth (shearling) ewes	1,477	1,092	901
Other sheep one year old and over	1,021	950	806
Total	**9,863**	**6,252**	**6,143**
Sheep under one year old:			
Ram lambs for service	156	62	69
Other sheep and lambs under one year old	7,967	3,848	4,647
Total	**8,123**	**3,910**	**4,716**
TOTAL SHEEP AND LAMBS	**17,986**	**10,162**	**10,858**
Sows in pig	(a)	66	99
Gilts in pig	(a)	35	75
Other sows for breeding	(a)	44	75
Total sows for breeding	**449**	**146**	**249**
Barren sows for fattening	(a)	10	13
Boars for service	30	11	15
Young boars being reared for service	(a)	5(4.9)	9(8.6)
All other pigs:			
Five months old and over	633	400	395
Two to five months old	1,516	369	560
Under two months old	888	205	391
TOTAL PIGS	**3,515**	**1,146**	**1,632**
Fowls:			
Six months old and over	23,154	17,480	19,596
Under six months old	29,758	20,376	28,268
Fowls, Total	**52,912**	**37,856**	**47,863**
Ducks, Total	**2,237**	**1,963**	**2,335**
Geese, Total	**584**	**731**	**913**
Turkeys, Total	**693**	**511**	**742**
TOTAL POULTRY	**56,426**	**41,060**	**51,853**
Horses used for agricultural purposes:			
Mares (including those kept for breeding)	347	403	224
Geldings	202		160
Unbroken horses of one year old and over (Light)	110	61	17
,, ,, ,, ,, (Heavy)			30
Horses under one year old (Light)	15	8	7
,, ,, ,, (Heavy)	35	11	7
Stallions being used for service (Light)	5(4.6)	2(2.0)	1(1.0)
,, ,, ,, (Heavy)			1(1.3)
All other horses (not entered above)	132	113	90
TOTAL HORSES	**846**	**597**	**538**

(a) Not separately returned.

AGRICULTURAL STATISTICS: ENGLAND AND WALES

LABOUR

(thousands)

Description	1939	1947	1948
Regular Workers :			
Male, 65 years old and over	375.3	27.6	27.6
,, 21 years old and under 65		368.2	391.6
,, 18 years old and under 21	44.7	45.2	47.4
,, under 18 years old	50.8	50.6	39.9
Total	**470.8**	**491.6**	**506.5**
Women and girls	40.3	56.8	57.3
Total Male and Female	**511.1**	**548.4**	**563.8**
Women's Land Army	—	17.7	16.5
Prisoners of War	—	78.7	11.4
Casual Workers :			
Male, 21 years and over	57.4	76.4	90.4
,, under 21 years old	5.9	7.5	8.4
Total	**63.3**	**83.9**	**98.8**
Women and Girls	32.7	48.0	50.4
Total Male and Female	**96.0**	**131.9**	**149.1**
Total Male Workers	**534.1**	**654.2**	**616.7**
Total Female Workers	**73.0**	**122.5**	**124.1**
TOTAL WORKERS	**607.1**	**776.7**	**740.8**

AGRICULTURAL INDEX NUMBER

Monthly Index Numbers of Prices of Agricultural Products Including Government Grants. (Base 1927–29 = 100)

Month	Uncorrected for Seasonal Variation					*Corrected for Seasonal Variation*				
	1939	1946	1947	1948	1949	*1939*	*1946*	*1947*	*1948*	*1949*
January ..	95	199	217	241†	245†	*89*	*179*	*193*	*215*†	*218*†
February	94	201	211	240†	243†	*88*	*182*	*190*	*217*†	*220*†
March ..	91	192	201	232†	238†	*91*	*183*	*191*	*220*†	*225*†
April ..	90	176	186	214†		*95*	*182*	*192*	*222*†	
May ..	82	162	171	198†		*91*	*181*	*192*	*222*†	
June ..	80	161	170	197†		*89*	*181*	*193*	*225*†	
July ..	85	168	181†	198†		*93*	*182*	*197*†	*216*†	
August ..	86	176	192†	211†		*91*	*191*	*208*†	*228*†	
September	92	177	206†	210†		*93*	*188*	*222*†	*227*†	
October ..	96	192	221†	226†		*92*	*187*	*215*†	*221*†	
November	106	209	235†	239†		*98*	*192*	*217*†	*222*†	
December	113	214	241†	246†		*103*	*192*	*216*†	*221*†	

† Provisional.

THE MINISTRY'S PUBLICATIONS

Since the date of the list published in the March, 1949, number of *Agriculture* (p. 548), the undermentioned publications have been issued.

Bulletins Copies are obtainable at the prices mentioned from the Sales Offices of H.M. Stationery Office or through any bookseller.

No. 21 Domestic Preservation of Fruit and Vegetables (*Revised*) 2s. 0d. (2s. 2d. by post)
No. 92 Chrysanthemums (*Revised*) 1s. 6d. (1s. 8d. by post)
No. 141 Fruit Growing Areas on the Hastings Beds in Kent (*New*) 1s. 3d. (1s. 5d. by post)

Advisory and Animal Health Leaflets Single copies of not more than 16 leaflets (four in any one group) may be obtained, free of charge, on application to the Ministry, 1-3 St. Andrew's Place, Regent's Park, London, N.W.1. Copies beyond this limit must be purchased from the Sales Offices of H.M. Stationery Office, net price 1d. each (2d. by post), or 9d. per doz. (11d. by post).

Group I. Livestock and Dairying
No. 33 Home Preservation of Eggs (*Revised*)

Group II. Pests and Diseases of Farm and Horticultural Crops
(b) Fungi
No. 340 Cucumber Mosaic (*New*)

Group V. Weeds
No. 345 Weed Control in Linseed and Flax (*New*)

Animal Health Leaflets
No. 9 Swayback in Lambs (*Revised*—superseding Advisory Leaflet No. 301)
No. 12 Blackhead in Turkeys (*Revised*—superseding Advisory Leaflet No. 20)
No. 13 Salmonella Infection of Poultry (*Revised*—superseding Advisory Leaflet No. 298)
No. 19 Trichomonas Disease (*Revised*—superseding Growmore Leaflet No. 90)
No. 21 Stomach Worms in Sheep (*Revised*—superseding Advisory Leaflet No. 275)

Other Publications
Technical Communication No. 8: DDT and the Apple Capsid Bug (*New*) Free
Management in Farming: Report of the Farming Management Conference at Winchester, February, 1949 (*New*) 1s. 6d. (1s. 8d. by post)

BOOK REVIEWS

Commercial Apple Growing. A. H. Hoare. The Bodley Head. 12s. 6d.

The second revised edition of this book has made its appearance after ten years—a period that has been crowded with changes in the many phases of commercial apple production.

Although relatively small, the author has packed this book with essential details and practical knowledge in a very readable form. Additional value lies in the fact that it links the result of research investigations with their practical application to modern methods of production. The work is principally concerned to assist the commercial fruit-grower, but it is of value to students at universities and farm institutes, and to those who contemplate fruit-growing as a livelihood. Young men coming into the industry are advised first to spend a year or so on the farm of a progressive grower, in addition to attending courses at an agricultural college or specialist farm institute.

In the chapter dealing with a survey of production, I doubt if everyone will agree that . . . "it would be fairly safe to say that we are near saturation point in the production of cooking apples. . ." There is less competition in cooking apples from overseas, but sales in this country could be improved by better grading and presentation. It is pleasing to note that the author has a good word for the commission salesman, for it is true that the closer the grower works with salesmen of repute the better for both parties.

There has been a tendency to market varieties before they are suitable in texture or quality, and the author rightly condemns this. "There is no surer way of losing public support for home-grown apples than this growing practice of stealing a march with our dessert apples."

C.H.O.

Fat Lamb Production. UNIVERSITY OF LEEDS AND YORKSHIRE COUNCIL FOR AGRICULTURAL EDUCATION. Jowett and Sowry. (Free issue.)

Many farmers in the North are familiar with the Leeds University reports of experiments to ascertain the value of rams of different breeds for the production of fat lambs. The emphasis on livestock production in the expansion programme makes it opportune that the University is now able to carry the matter a stage further by publishing data on the significance of the breeding of the ewe in relation to the same problem. There is no doubt that grass sheep will play an important part in utilizing the extra grass produced and in maintaining fertility; and what is more important to the farmer than information on the right kind of sheep to use?

The experiments now reported compare the efficiency as mothers (for fat lamb production) of first-cross ewes obtained by crossing the Swaledale ewe with the Border Leicester, Suffolk, and Wensleydale ram, respectively. The Hampshire was used as the common factor in obtaining the second-cross lambs. Much valuable information is given, covering fertility, productivity, and longevity of the ewes, ability of the ewes to rear lambs, birth-weight of the lambs, age of lambs when sold, live-weight of lambs when sold, rate of live-weight increase of the lambs, carcass percentages, grading of carcasses, prices realized by the lambs, financial return per ewe, and gross average output per ewe. Farmers, advisers, and students will find this report well worth studying.

The results suggest that the Yorkshire hill farmer is not far wrong in looking with most favour on the Wensleydale-Swaledale cross, because this cross gave the best return in the admittedly limited scope of this part of the experiment. From the point of view of the farmer buying wether lambs (for turniping) from the hill first-cross, the evidence was in favour of the Suffolk-Swaledale cross, as measured by the sale value of the fat hoggs, but this advantage tended to be neutralized by food and labour costs, so that this particular farmer might well be content to accept wether lambs of any of the three crosses tried.

The most important conclusions are those referring to the provision of a first-cross ewe for the production of fat lambs on lowland grass over a period of several years. Here the hardiness, fertility, and maternal characteristics of the Suffolk won, and the Swaledale-Suffolk cross gave the highest gross return, beating the Wensleydale cross and the Border Leicester cross by £2 14s. and £3 15s. per head, respectively.

D.S.H.

Farm Life in a Yorkshire Dale: A Study of Swaledale. W. H. LONG and G. M. DAVIES. Dalesman Publishing Company. 5s.

For some people there is a forbidding quality about the study of economics, but when the subject-matter is presented in a bright and interesting way, as in this little book, it becomes truly fascinating reading.

Having sketched in a picture of this most beautiful of Yorkshire dales and told something of its history, including "the violent jolts" which its economic life has received from the lead mining industry, the authors proceed to a detailed description of its farming, now practically the only occupation of a local population whose numbers fell by 56 per cent between 1871 and 1931. The Dale has found it necessary to develop its agriculture from the traditional sheep and cattle rearing to a wider economy embracing milk selling, coupled with the export of young dairy stock. A great deal of financial information, based on the accounts of twenty farms is given in the book and its appendices. Profits are not large—no more than £390 per year on "milk" farms and £500 per year on "sheep" farms. This has to suffice for interest on capital, reward for enterprise, and recompense for manual work which, in the great majority of cases, takes up most of the farmers' time.

It is interesting, however, to note that the authors consider the rewards from this way of life to compare favourably with a farm worker's wages plus the returns from the investment in securities of an equal amount of capital. But this result is obtained only by cutting out all unnecessary cash outlay, including in most instances the "luxury" of a car; and the hill subsidies are indispensable. It will be encouraging to many who fear that this type of farming is in danger of extinction to note the authors' views that farming in Swaledale offers satisfactory opportunities for successful family farming.

The important conclusion is drawn, which should be noted in relation to other similar farming types, that any material reduction in returns would turn the scales against continuation of farming and tend to an increased rate of depopulation.

D.S.H.

Principles of Agriculture. W. R. WILLIAMS. Hutchinson. 15s.

It is often alleged that those who visit the U.S.S.R. generally return confirmed in their preconceived notions of what the conditions in that country are really like; that they have seen only what they expected to see, whether good or bad; that very few visit it with an open and unbiased mind, and fewer still, as a result of their visit, change a mind already made up.

To review a Russian book seems open to the same dangers, and demands special care that all prejudice should be avoided. The author begins by quoting with approval a dictum of Lenin's that bourgeois scientists had thought out the law of diminishing returns "in order to mask the capitalistic impediments to agricultural progress"! Comment of this sort is apt to prejudice a reader, and may result in his paying insufficient attention to a valuable book which contains some novel ideas and theories which, though admittedly controversial, are yet stimulating and worthy of serious consideration.

The title is misleading to us in this country who associate such titles with agricultural textbooks of a very different nature. This is not a textbook which could be read by the ordinary agricultural student for, though parts of it might be valuable to him, there are other parts that he could not understand, and much which would only confuse him. It is certainly not a book which could be recommended to farmers. Undoubtedly it should, however, be read by all who are interested in soil science. The ground covered by the book can be summarized by the author's own words:

"The whole science of agriculture is summed up . . . by firstly, the system of cultivation, the object of which is to produce a structural condition in the soil, accompanied by the least possible amount of soil dispersion. Secondly, the system of fertilising, in order to maintain the maximum quantity of mineral plant nutrients in the soil, and to convert them into organic forms. Thirdly, the system of restoring soil fertility, the object of which is to counteract the natural tendency towards a loss of structural stability in cultivated soils. And fourthly, the creation of a fodder base. These four systems embrace the whole range of agricultural knowledge."

W.S.M.

The Journal of Soil Science, Vol. 1, No. 1 (March, 1949). BRITISH SOCIETY OF SOIL SCIENCE. Oxford University Press (Geoffrey Cumberlege). 17s.

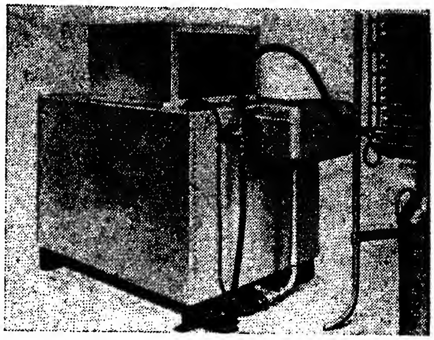
This important new annual journal, edited by G. V. Jacks, M.A., Director of the Commonwealth Bureau of Soil Science, exists for the publication in English of papers of a high scientific standard, either presenting the results of original research in the field of soil science or reviewing within this field. It is the organ of the recently-formed British Society of Soil Science, but its pages are open to research workers, whether within or outside the British Commonwealth.

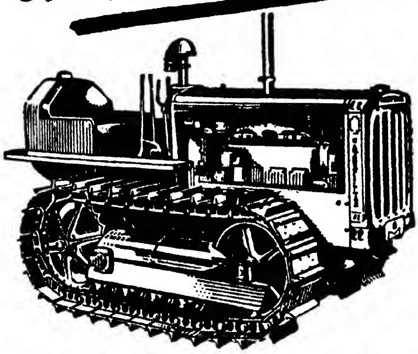
The first number, of about 120 pages, presents eleven papers comprising studies of the electric charges carried by clay particles; the effect of weather and soil conditions on the loss of water from soil by transpiration; the correlation between climatic factors and the degree of soil leaching; various kinds of podzolic soils in Wales and north-east Scotland and frost soils on Mount Kenya; the movement of iron oxides in podzol soils; X-ray studies of soil clays and humification; and a review of present knowledge and future questions concerning lake sediments.

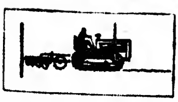
The Journal's attractive production should ensure a warm welcome for this newcomer from soil workers everywhere.

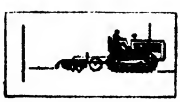
W.D.B.

Printed in Great Britain under the authority of HIS MAJESTY'S STATIONERY OFFICE by C. Nicholls & Company Ltd., The Philips Park Press, Manchester, London and Reading.









Please mention the JOURNAL *when corresponding with Advertisers*

'ALBERT'

Basic Slag

FOR ALL CROPS

★ *Literature and advice free from J. Harold Thompson, B.Sc. (Agric.), Chief Agricultural Adviser BRITISH BASIC SLAG LTD., Wellington House, Buckingham Gate, S.W.1, WHItehall 2904 or in Scotland to J. S. Symington, B.Sc. (Agric.), 37 Castle Street, Edinburgh. Tel. Edinburgh 23582.*

NO OTHER MACHINE...

HAS THIS UNIQUE PULSATOR

BE SURE THAT IT'S A

FULLWOOD

BUCKET AND RECORDER RELEASER PLANT

***R. J. FULLWOOD & BLAND LIMITED**

ELLESMERE, SALOP & 31 BEVENDEN ST., LONDON, N.1

Ellesmere 29 & 169 *Clerkenwell 4406*

*No connection with any other British or Foreign Manufacturers of Milking Machines.

—here is the evidence!

'FusareX'

SEED POTATO DUST

TRADE MARK Patent applied for BRAND

CONTROLS DRY ROT AND SPROUTING

★ One of our many photographs showing the effect of 'Fusarex'.
Variety Ulster Chieftain, grown in Cheshire.
Note untreated potatoes (*right*) compared with 'Fusarex' treated.
Ask for our free illustrated literature.

BAYER PRODUCTS LTD · AFRICA HOUSE KINGSWAY · LONDON · W.C.2

COPPER COMPOUNDS

in Agriculture

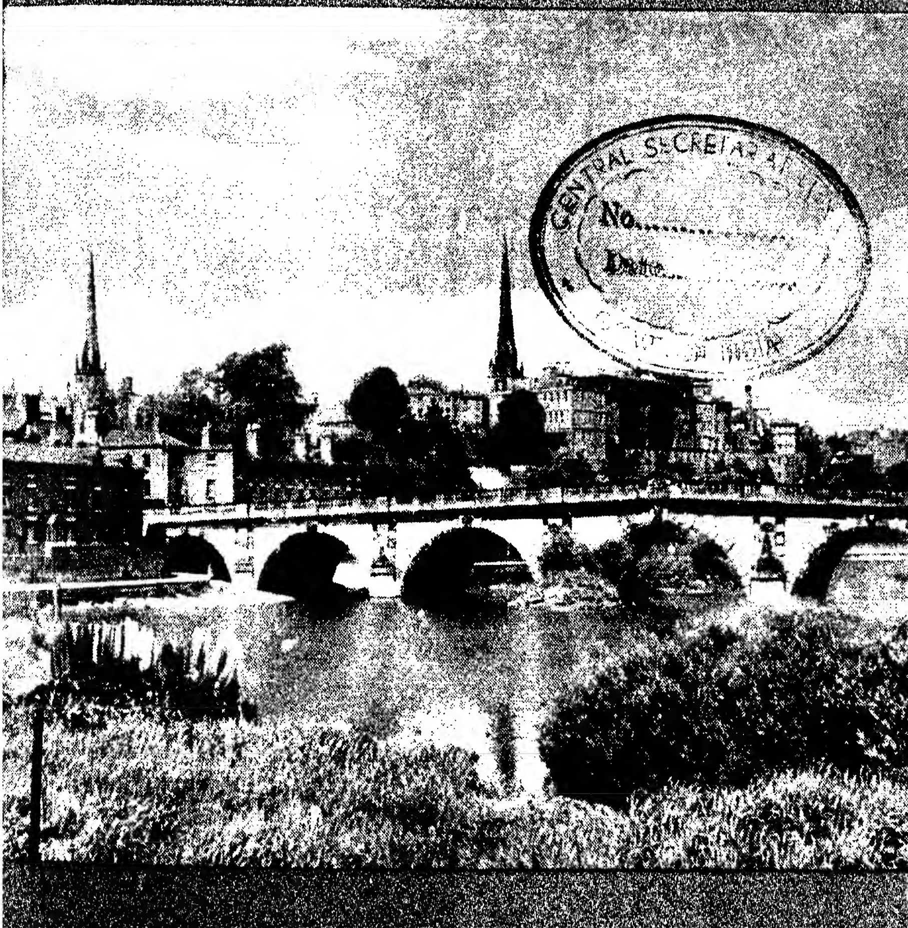
This C.D.A. book deals with the prevention of the loss of potatoes due to blight. It also surveys the uses of copper compounds in protecting certain other crops from fungus diseases and in combating 'deficiency diseases' in plants and animals due to lack of copper in the soil. A copy may be obtained by any applicant genuinely interested, free of charge or other obligation. For this or any other information on the uses of copper, write to the Copper Development Association, Kendals Hall, Radlett, Herts. (Radlett 5616)

A1/48

Please mention the JOURNAL *when corresponding with Advertisers*

Agriculture

The Journal of the
Ministry of Agriculture



VOL. LVI No. 4

PUBLISHED 6d MONTHLY

Please mention the JOURNAL *when corresponding with Advertisers*

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

Editorial Offices: St. Andrew's Place, Regent's Park, N.W.1 (*Phone: WELbeck* 7711)

VOL. LVI No. 4 JULY 1949

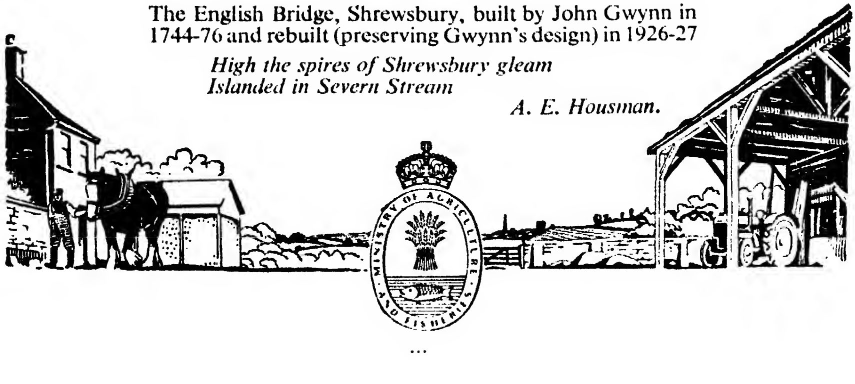
Contents

Cover Photograph

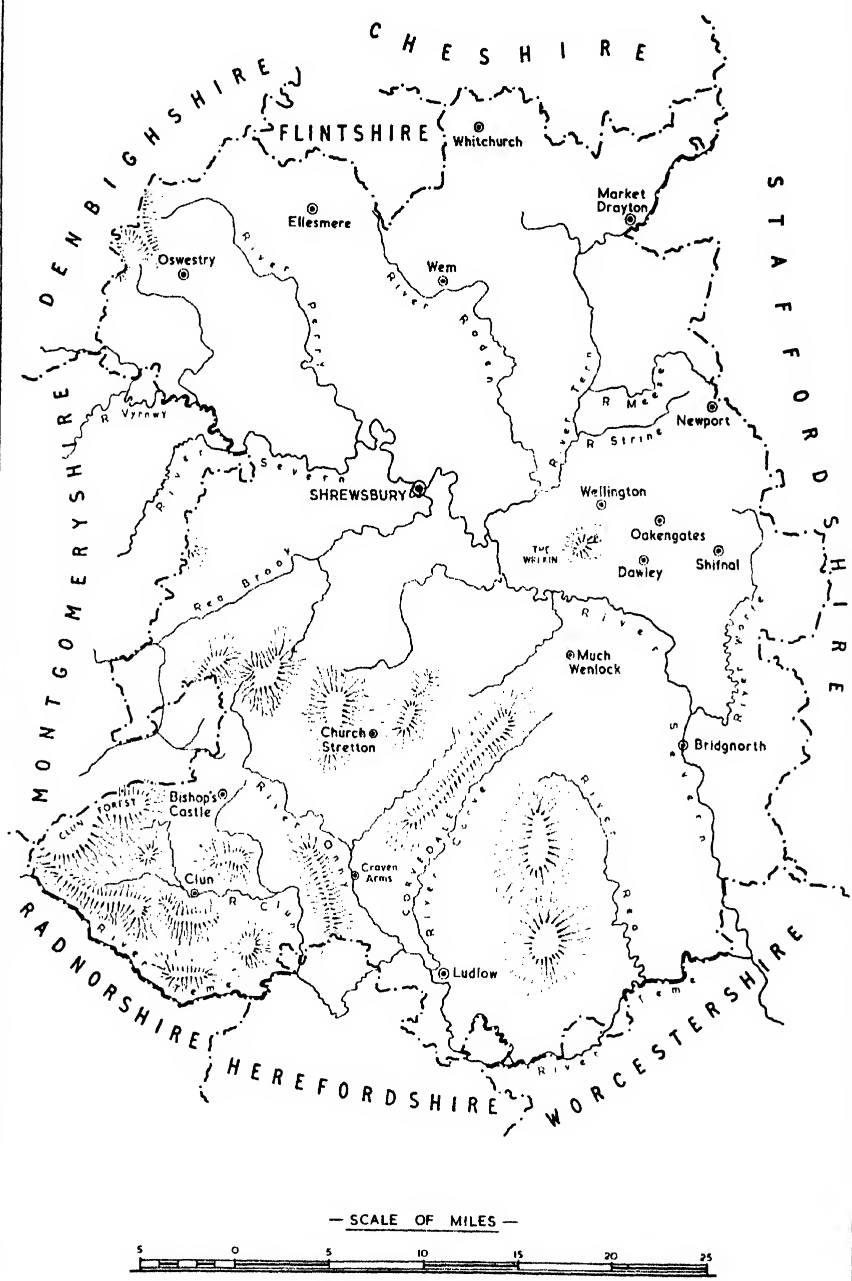
The English Bridge, Shrewsbury, built by John Gwynn in 1744-76 and rebuilt (preserving Gwynn's design) in 1926-27

High the spires of Shrewsbury gleam
Islanded in Severn Stream

A. E. Housman.



SHROPSHIRE


CHESHIRE
DENBIGHSHIRE
FLINTSHIRE
STAFFORDSHIRE
MONTGOMERYSHIRE
RADNORSHIRE
HEREFORDSHIRE
WORCESTERSHIRE
Whitchurch
Market Drayton
Ellesmere
Oswestry
Wem
River Perry
River Roden
River Tern
R Meese
R Strine
Newport
R Vyrnwy
Severn
SHREWSBURY
Wellington
Oakengates
THE WREKIN
Shifnal
Dawley
Rea Brook
River Severn
River Worfe
Much Wenlock
Church Stretton
Bridgnorth
Bishop's Castle
CLUN FOREST
River Onny
Craven Arms
CORVEDALE
River Corve
River Rea
Clun
R Clun
River Teme
Ludlow
River Teme
SCALE OF MILES
5
0
5
10
15
20
25

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LVI No. 4 JULY 1949

THE GEOGRAPHICAL BACKGROUND TO WEST OF ENGLAND FARMING

Professor L. DUDLEY STAMP, C.B.E., D.Sc., B.A.

FEW countries of equal size anywhere in the world can boast the variety of scenery to be found in Britain. That scenery reflects not only the geological and physical build of the land and its soils but also very markedly the consequent use which the farmer has made of the countryside. Shrewsbury, the venue of the 1949 Royal Show, is almost unique in the scenic and farming contrasts to be found within a radius of 50 miles.

Geologists and geographers commonly make a broad twofold division of Britain into Highland Britain (the north and west) and Lowland Britain (the Midlands, south and east). For the most part Highland Britain comprises hilly country built up of the older rocks, where hills attract a heavy, often excessive, rainfall, and soils are thin, poor, and sour. In Highland Britain human settlement tends to be restricted to the valleys, and the cultivated lands are often separated by wide stretches of unenclosed moorland. The bulk of Wales and the Welsh border lands—that is, the country to the west and south-west of Shrewsbury—belongs to Highland Britain, and is of this general character.

Lowland Britain, on the other hand, not only comprises land which for the most part is less than 1,000 feet above sea level and consists of the younger geological rocks, breaking down more easily into deeper and richer soils, but also tends to have more moderate rainfall and to provide, in general, soils which the farmer can cultivate either by the plough or under grass. Lowland Britain includes the plains which actually surround Shrewsbury and stretch away to the north into Cheshire, to the north-east into Staffordshire, and south-eastwards into Worcestershire.

Looked at in more detail there is, of course, a very great variation in Lowland Britain. In places its rolling plains are interrupted by hill masses, some of which may be small and conspicuous, like the Wrekin, others larger, though lower, like the Black Country and Cannock Chase, but most of which are marked by the outcrop of older rocks, as it were in islands surrounded by younger rocks. Economic conditions on these hill masses, from the farmer's point of view, are poorer than on the lowlands proper.

If we look upon Shrewsbury as centrally placed in the county of Salop, to the north there lies Cheshire, to the south Herefordshire, whilst to the north-east there is Staffordshire and to the south-east Worcestershire. It is worth while to look briefly at the geographical background of farming in each of these counties.

Shropshire The large, roughly rectangular county of Salop, or Shropshire, can be divided into a northern and a southern half by an irregular line which runs east and west, a little to the south of Shrewsbury itself, and which terminates eastwards in the Wrekin.

NORTH SHROPSHIRE is a plain over which the retreating ice sheets of the Great Ice Age deposited their load in the form of boulder clay, with glacial sands and gravels. This drift-covered plain was once dotted with innumerable lakes occupying the hollows, but most of these lakes have since dried up, though remnants (they are usually known as "meres") still remain in places. But it is not surprising that the soils of the North Shropshire Plain are remarkably varied. There are dark, peaty soils of the old moors. There are stretches of fine loam, or silty deposits of the old glacial lakes. There are areas of fine and coarse sand, also of glacial origin—sometimes so coarse and hungry as to be of little use, except as heathland. There are large tracts, too, of boulder clay, sometimes heavy, stony, clayey, and other times lighter and more loamy in composition. Arising out of the drift-covered plain there may be occasional islands of sandstone, whilst here and there such hills as the Breiddens mark the outcrop of some resistant underlying rock.

Thus farming conditions over the North Shropshire Plain vary in detail, and the land is described in general terms as "devoted to dairying with various subsidiary enterprises".

SOUTH SHROPSHIRE, by way of contrast, is a land of hills, arranged in long ridges, such as Wenlock Edge, or isolated piles, such as Caer Caradoc, or bleak plateau, such as the Long Mynd, between which are valleys and lowlands, in places remarkably fertile.

The poorer and higher lands, of which the Long Mynd is the best example, are moorlands of little agricultural value, except for a few hill sheep, and the greater part of South Shropshire devotes its attention to rearing, though often supplemented by other enterprises, especially in the more accessible valleys. In the south-west of Shropshire, in the well-known Clun Forest area, hill sheep farming becomes the dominant occupation.

Before leaving Shropshire, we should notice that the North Shropshire Plain sends tongues westwards amongst the Welsh Hills into Montgomeryshire, whilst in the north-west of the county those same Welsh Hills overlap the border into Shropshire itself and the hill sheep lands overlook the fertile plains. To the east of Shropshire we find a larger proportion of arable land stretching into Staffordshire, where the farming can be described as essentially mixed. It is in this area that much sugar beet is grown.

Cheshire In general, the heart of Cheshire, the famous Cheshire Plain, is a northward continuance of the Shropshire Plain. There is the same wide variety of glacial or drift deposits, there are the same islands of sandstone or older rocks, giving rise to such poorer tracts as that occupied by Delamere forest. There are the same Welsh Hills overlooking the plain from the west, whilst on the east there are the foothills which are the outer ramparts of the Pennines. The heart of Cheshire is, of course, one of the most famous, if not *the* most famous, of the dairying areas of Lowland Britain. In most parts of the Plain the former almost exclusive reliance on permanent pasture has given place to dairying based on a more extensive use of the plough, and there are parts of the Cheshire Plain which rank high in land quality under almost any crops. This heart of the Cheshire Plain is precious land which needs to be protected in every way possible from the onslaught of those who seek, rightly enough, to find sites for new towns or industrial expansion. In this regard Cheshire is in a vulnerable position, because of the need to find new accommodation for the "overspill" populations of Liver-

pool, Birkenhead, Manchester and the Pottery towns. Unfortunately the well-drained, gently rolling land, so productive of much-needed food, is also the most attractive to the industrialist and town planner.

Herefordshire Lying to the south of Shropshire is one of the most remarkable counties in England—Herefordshire. The county town, Hereford, lies approximately in the centre of a broad, open basin of rich, red soils, derived from the Old Red Sandstone and marls. There are, of course, islands of older rock rising from the surface, but the Herefordshire basin gives place on all sides to rolling hills : to the Black Mountains in the south-west, the hills on the Radnorshire border in the north-west, whilst Herefordshire is cut off from its neighbour, Worcestershire, on the east by that thin but conspicuous line, the Malvern Hills and their continuation northwards. On the *Types of Farming Map*, prepared by the Ministry of Agriculture and Fisheries, the Herefordshire Plain, or basin, is described as "mixed farming, with a substantial rearing or feeding side". It is the home of the Herefords and still their great stronghold. It is a country where hop gardens and orchards bear witness both to soil quality and to a relatively low rainfall. Only on the hilly margins does rearing take the place of mixed farming.

Worcestershire In many ways Worcestershire is the most favoured of the Midland counties of England from the farmer's point of view. Its varied soils, many of glacial origin, are on the whole highly fertile. There are certain river terraces which are outstanding in this respect. But Worcestershire also has the climatic advantage of a rainfall as low as that in eastern England, combined with a relatively early spring and, in many tracts, an absence of frost pockets. Not unnaturally, farming interest centres on the Vale of Evesham, with its intensive market gardening and fruit production. The market gardens, whether of the big man or of the small holders, have extended beyond the fertile terraces of the Avon to hill slopes and poorer land beyond, but this is a region unique in the country.

Much of the remainder of the county has red soils of glacial origin, but in each the bulk of the material is derived from the underlying Keuper marls and sandstones, soil light enough to be easily worked, but heavy enough to be retentive of moisture. This is country now devoted mainly to dairying, with the enormous consuming markets of Birmingham and the Black Country just to the north. Rather lighter soils, which are predominant in the western part of the county, have more extensive areas under the plough, but again dairying must be described as the dominant farming enterprise.

Staffordshire Apart from the infertile upland of Cannock Chase, stretching southwards into the old Black Country, and the industrialized area of the North Staffordshire coalfield, the large county of Staffordshire falls broadly into two parts. The north-eastern sector belongs strictly to the Pennines. There are gritstone areas and some limestone areas adjoining those of Derbyshire, and this is country where, whatever may have been the farming enterprise in the past, the focus is now on dairying. Much of the land is unsuitable for ploughing and the emphasis in pre-war years was on grassland management.

The south and west of Staffordshire belong to the same general belt as we have already mentioned in north-western Worcestershire and in eastern Shropshire—low, rolling country of varied soils, which the Ministry's map shows as "mixed farming with a substantial dairying side".

Summary To try and summarize what we have already said, Shrewsbury lies in the centre of country where farming of the most varied types is carried out, but we notice wherever the matter is studied how very markedly the type of farming is dependent upon the geology and soils and the relief of the land. We find every stage from what can be ranked as the most fertile and most productive land in the world to bleak, barren hill moorland, virtually uninhabited by both man and beast. The really fertile areas of first-class land are restricted and are of the utmost value in the national economy.

ADVISORY WORK IN THE WEST MIDLANDS

W. B. Mercer, M.B.E., B.Sc., N.D.A.
Provincial Director, West Midland Province

TIME was when every district had its appropriate form of farming. Geography, soil, climate and the forces of history combined to induce systems of land management exactly attuned to circumstances ; every area had its own particular problems which it solved in its own particular way ; the law was as neat and tidy as Adam Smith's political philosophy. Or so it seems as one looks back over the war-scarred years.

As usual memory plays us false. Farm life never was as simple as it seems in retrospect. It did not really divide into watertight compartments. In this part of the country it was convenient to regard practice as falling in one or other of five systems—the dairying regime of Stafford and Cheshire ; the arable and beef of Central Shropshire ; the upland rearing of Hereford ; the summer grazing on the clays of Warwick, and the fruit-vegetable-dairy complex of the small farms of Worcester. But this was a broad generalization never wholly true, for dairying always interlocked with feeding ; there was a first-class arable tradition in parts of Hereford, and early potatoes were a key crop in North Cheshire. What distinguishes the farming of today from that of pre-war days is the fact that all systems have been subjected to a common strain and all bear the marks of that strain.

War-time Changes With the war came mechanical devices of power, speed and weight hitherto undreamed of ; it presented all stockmen alike with the problem of self-sufficiency, and it rendered clamant a solution of that human problem which has vexed the countryside since the time of the Black Death—the share of the labourer in the fruits of his toil. Gradually these forces began to dominate those of nature and of economic history. Everywhere the problem of maintaining existing or customary stocks became the prime consideration. As the plough bit deeper, even upland farms began to take on an appearance reminiscent of the lowlands ; ant-hills, rabbits and bush disappeared from the lias (before the war the traveller to London could always tell when he ran on to the lias by the ant-hills) ; the smallest farms began to depend on tractor power.

Though the introduction of the tractor tended to iron out area differences in craftsmanship, a high degree of specialization remains. In their way the arable arts of mid-Shropshire, where beet and carrot singling have been brought to perfection, are almost as striking as the celebrated manual

cunning of the Evesham market-growers on their crowded acres. Some measure of adjustment of working hours to modern conceptions has been effected in most districts; and though the cowman still carries his seven-day burden, human ingenuity, aided by mechanical devices, has evolved methods of lessening the continuity of his toil. The slow process of rural re-housing, the even slower spread of electric current, and the recasting of wage rates, begin to show their effects in population statistics. At long last the downward droop of the agricultural workers' graph has flattened out, and now slightly risen.

It is against this background of a countryside in the throes of great physical and social changes that advisory work must be viewed. As usual under stress of adversity, technical progress has been rapid. All sorts and conditions of men have brought their influence to bear. Pioneer farmers—whether as members of Executive Committees or as private individuals—county staffs, university and college advisers, staffs of several divisions of the Ministry, have all played their part. Great research centres at Long Ashton and Drayton have illumined the area like Portia's potent candle. In this article no attempt is made to assess the respective influences of these several forces; it aims merely at drawing in broad outline the results achieved.

Soils and Land Management There is very little bad land in the West Midlands. Apart from the Bunter pebble beds of Cannock Chase and the bare mountain tops of Central Shropshire, scarcely anything is uncultivable. Most of the hill lands have soils of considerable depth, the outcrops of the Old Red Sandstone being particularly fruitful—a fact which has been turned to good account in reclamation work. Lime shortage is general throughout the glacial drift areas, on the New Red Sandstone and on the Millstone Grits of North Staffordshire. Phosphate deficiency has also been common on permanent grass. Soil analyses, carried out by tens of thousands annually, the lime subsidy, the development of contract work in mechanical lime spreading and the general urge for higher production, have together effected great improvements in the level of fertility of the area. It is unfortunate that seasonal effects invalidate comparisons of average crop yields. All competent observers are, however, agreed that yields in general have risen in recent years as a result of rising soil fertility. Troubles from trace elements are rare, though "teart" is occasionally encountered. A trouble in milking stock on peat lands, attributable primarily to low copper in the blood, and a trouble amongst sheep in one river valley, suggestive of cobalt deficiency, are noteworthy exceptions to the general rule.

Cultivation The major cultivation difficulties, apart from economics, arise from the slow-draining quality of the boulder clays and the peculiar physical consistency of the lias clays. Soil profile studies frequently prove of value in fruit- and hop-growing areas, where depth of soil and evenness of water distribution are of particular significance. Old Red soils of great fertility and apparently of great depth, for instance, frequently show a curious stratum of almost powdery dryness at 18 inches, rendering them quite unsuitable for fruit. Cultivation of the lias has evoked bold experimentation. The crawler tractor has completely changed the problem of management of these intractable clays. Under carefully timed attack with powerful tools, a third-rate grazing area has become a source of 1½- and 2-ton wheat crops, and leys on which wild white clover runs riot. If the lias all lay in big farms to which water could be brought,

it could fairly be claimed that the problem of its management was solved. It will carry three crops of wheat in succession, then three or four years of first-class ley, but that means big expanses for the plough and big tools. Much of the lias is, in fact, covered with smallholdings. Where they are equipped for milk production, well and good; where they are devoted to rearing, the problem of economic management at a high level of production is still unsolved. At the other extreme, light tractors with appropriate row-crop tools have created a new technique of beet cultivation on the light soils of Bridgnorth and Newport; with these implements an even higher degree of precision has been developed than was achieved in the days of horse tools, while labour costs have been strikingly reduced. There has been a notable shift in the timing of green crop operations—a concentration of effort in the early weeks after sowing or planting. The present-day routine on the best farms involves rough treatment of the young plants, but gives a far higher degree of control of weeds than the gentle, more leisurely procedure of days gone by.

Tillage No problem in land management has occasioned more thought and anxiety than that of the optimum area of plough land. In the earlier war years wheat, beet, potatoes and barley were expanded greatly, much of the permanent and temporary grass was ploughed; yet the total head of cattle tended if anything to rise (admittedly sheep were to some extent sacrificed). Later the tillage area began to decline, again without measurable effect on cattle numbers. *A priori*, a good case can be established today for restoring the peak tillage area. It is, however. doubtful whether statistics of stock tell the full tale; they count heads but take no account of growth-rates and body condition. Moreover, greater weight now attaches to the economics of production; more attention is being paid to greater production from grass, with its promise of protein-sufficiency. Clearly the problem admits of no general solution, but must be worked out painfully on each farm.

Fodder From the outset of the crisis it was obvious that protein would be a great problem in this heavily stocked area. Beans, as a self crop or mixed with cereal, were tried extensively. Despite endless modifications of methods of cultivation, however, sure-founded knowledge has not advanced far beyond the point we started from—to wit, that beans thrive well on certain soils and fitfully or not at all on others. Linseed, again, has not yet generally yielded protein measurably greater than that obtainable from other sources. On the whole, the nearest approach to a solution has been found in liberally treated kale, in mixed corn and pulse, and above all in grass. It should, however, be said that shortage of protein as a specific ingredient of winter fodder has proved, in every hard winter since 1939, of less consequence—or at least of less demonstrable consequence—than mere fill-belly. Young stock have had to endure some grisly winters. Grass management has without doubt made great strides. The idea of intensive treatment with phosphates and nitrogen has grown fast; period leys, e.g., a ryegrass-dominated early ley and a timothy ley for later use have been accepted into farm routine; the idea of preparing leys for period grazing has gained wide acceptance.

Three features in connection with the establishment of grass call for special notice. Under a great variety of conditions, seeding without a cover crop has been found advisable. Some County Committees in the later war years directed large areas to be so treated. Most land reclaimed from bracken or derelict turf has been reseeded with a permanent mixture

on the upturned sod. In Hereford, however, owing largely to the place which sheep occupy in the economy of that county, a system of pioneer cropping with rape and similar sheep fodder has been evolved, the permanent or long ley mixtures being sown a year or two after the initial breaking up. Though experimental evidence is lacking, the belief in sheep as builders of the fertility required for establishment of a sward is very strong throughout this area, and in these days of meat shortage there is much to commend it.

Grass Conservation After a false start in the middle years of the war, grass preservation in the form of silage has grown rapidly : on some large dairy farms grass ensilage has now entirely replaced haymaking, and analysis of silage samples has become a task rivalling in magnitude that of soil analyses.

As a special feature of grassland husbandry, development of a considerable industry in herbage seed production is to be recorded ; and the design of methods of management to provide maximum fodder consistent with maximum seed yield constitutes one of the most intriguing of recent problems.

By and large, diseases and pests of crops have remained sporadic, despite very risky crop successions in some areas. Potatoes, the bugbear of Hereford, have been willingly—indeed over-willingly—grown in parts of Staffordshire to the extent of 30 or 40 per cent of the tillage area, to the great satisfaction of the potato eelworm. In certain years, Take-all and Eyespot have wrought widespread damage in wheat fields ; while the ubiquitous wireworm was a sore trial in the early years of the ploughing-out campaign. But, all told, these afflictions have not greatly lowered output. Of more general interest is the problem of holding stocks of material and machinery for distribution of pest deterrents—a problem but partially solved by the development of contract spraying work.

Livestock In animal husbandry the dairy cow has had pride of place. It is tempting to see, in the statistics of production, a reflection of the Ministry's campaign for better breeding methods. Output per cow, which fell sharply on the outbreak of war, has since risen steeply. The following figures of milk sales from Cheshire are typical of the area:

1938/39	1941/42	1944/45	1948/49
73.7	66.8	73.6	84.4

Clearly better breeding could not alone have had this effect, though it is probably now the major factor. There has been a considerable swing from dual-purpose to pure dairy breeds, and the first fruits of A.I. are being gathered. But the initial recovery must be ascribed to improved feeding and management—factors which continue to play an important part. Considering the magnitude of the industry, both recording and the drive for tubercle-free herds have made good progress. The introduction of the National Milk Testing and Advisory Scheme brought to this area an immense task ; in the nature of things a task in which success can be measured but roughly—and that only over a period of years. That the scheme has broadly achieved its purpose scarcely allows of doubt ; but there must be many amongst the labourers in this field who reflect sadly that while man's work runs from sun to sun, a woman's work is never done.

Much less satisfactory is the record of quantitative composition of milk. The slow fall in the percentage of fat and of other solids in milk, noted in other parts of the country, has here become a matter of major

concern, for the proportion of deliveries falling below the presumptive standards in the spring of each year is very disconcerting, and unfortunately short-term remedies have up to now proved mere palliatives.

Total Output Measurement of agricultural output is notoriously difficult owing to the variety of products involved, the extent of inter-farm trading, the importation of the products of other lands, and so on. At least a rough idea of trends can, however, be gathered from the returns of acreages and stock numbers, if appropriate standard monetary values are given to each. Excluding pigs and poultry (whose produce derives mainly from overseas), the aggregate annual output of the six counties* in 1939 and 1948 respectively can be expressed as follows:

Index Value of Output

	1939	1948
Cattle		
Herd increase ..	—	0.2
Young stock ..	27.1	30.0
Milk and cheese ..	52.0	54.7
Sheep		
Breeding flock decrease	—	0.4
Lambs and young stock	6.2	3.6
Wool	0.8	0.5
Crops		
Wheat and barley ..	5.9	13.6
Potatoes	6.6	14.7
Fruit	6.6	7.0
Vegetables	4.9	9.9
Hops	3.3	3.4
	113.4	137.2
Deduct for Feedingstuffs	13.4	5.6
	100.0	131.6

LOOK OUT FOR COLORADO BEETLE

The utmost vigilance is necessary during the coming months to prevent the Colorado beetle establishing itself in this country. This pest of potato crops is still prevalent over large areas of Europe, and although fewer colonies of beetles were found on our potato crops last year than in 1947, a number of beetles reached this country with imported produce or were intercepted on ships. The danger of infestation from this source is as great as ever and a few discoveries of single imported beetles have, in fact, already been reported this year. The success of measures for the eradication of the pest depends on prompt action, and the Ministry of Agriculture appeals to everyone to report any discovery of the pest immediately.

The Ministry's Advisory Leaflet No. 71 gives a full description. Any yellowish beetle about half an inch long with black stripes—running up and down the beetle, not across—or any red or reddish yellow grub found on potato leaves or among vegetables should be regarded as suspect, and specimens sent, preferably with a piece of potato leaf, in a tin box *with no holes* to the Ministry of Agriculture, Plant Pathology Laboratory, Milton Road, Harpenden, Herts., with a letter stating the exact place where found and the name and address of the finder. Nothing more should be done until instructions are received from the Ministry.

* Cheshire, Herefordshire, Shropshire, Staffordshire, Warwickshire, Worcestershire.

GRASSLAND DEVELOPMENTS IN THE WEST MIDLANDS

WILLIAM DAVIES, D.Sc.
Grassland Research Station, Stratford-on-Avon

THE pastures of certain parts of the Midlands have a world-wide reputation for their excellence. The renowned pastures of the Market Harborough district of Leicester and Northampton, for example, are some 70 miles from Shrewsbury, while the almost equally famous dairy pastures of the Cheshire Vale lie some 20 miles to the north of this year's Royal showground. Within the province we have other districts of grassland and livestock fame, such as the home of Hereford cattle, Clun, Kerry and Shropshire sheep, while over the Welsh border we find fine herds of Welsh Black cattle and Welsh mountain sheep grazing on the rough moorlands and marginal lands of the Principality and the border country. Taking the grasslands of the area as a whole, a critical examination shows that the area is dominated by *poor permanent grass* ranging from the heather, *Nardus* and *Molinia* moorlands of the hilly districts to the *Agrostis* pastures of the marginal lands and lowlands. The proportion of first quality permanent grass is low, but the whole district is well served by its equable climate and a well-distributed rainfall. The productivity of these grasslands is therefore appreciably higher than would appear from their botanical make-up.

The problem of increased production from grassland in the area is much the same as elsewhere in Britain. Most of the present permanent grasslands will ultimately have to be brought under the influence of the plough and replaced by high quality leys. Well over half the total agricultural land (excluding moorlands) in the province is still under permanent grass, largely of poor quality but with a very high potential output if farmed on a ley system. At present the proportion of leys to permanent grass is of the order of 1:3, and at the very least this position needs to be reversed so that leys shall dominate the landscape. That is one way towards higher production.

A further problem is to improve the quality of existing leys. There are far too many ill-conceived and ill-farmed leys everywhere. The ley, as all other crops, needs to be well farmed if it is to be at a high level of production. Where such a level is attained the ley will produce more animal feedingstuff than any other crop on the farm. This lesson needs to be driven home throughout British agriculture, and nowhere more so than in the West Midlands Province, where on the whole we have an almost ideal grassland climate. If our livestock industry is to develop properly, then we must farm our grasslands at the highest possible level, for it is to them that we must look to provide most of the food required by our livestock, whether in summer or in winter.

Early Work of the Grassland Improvement Station

There is much good farming in the province ; the soils vary from the very light sands of the Bunter to the obdurate clays of the Keuper and lias formations. The Grassland Improvement Station, at Drayton, three miles west of Stratford-on-Avon, occupies some 300 acres of heavy clay characteristic of the Midland and Eastern clays.

The Station started its work in 1940. Its first job was the reclaiming of land which during the 1920-40 period had become derelict, much as had scores of thousands of acres of other clay lands throughout Britain. The Drayton lands had once been well farmed in the nineteenth century arable tradition, but had gone out of cultivation in the agricultural depression which followed the disastrous harvests of 1876-79. The farm was unoccupied until 1915, when it was reclaimed under the food production drive of the first

World War. Again it became derelict, so that by 1940 the fields were either in extremely poor grass or in thorn and bushes. A few fields were still arable, but the crops were poor and showed all the results of bad husbandry. The years 1940-44 were employed in growing cereals and other farm crops, and at the same time conducting simple experiments designed to test the establishment and maintenance of differently constituted leys. Before 1940 there was extremely little experience available about methods of regrassing the clays. It was to this task that the energies of the Station were directed on an ever-increasing scale. By the harvest of 1944 the general principles of ley establishment on the heavy soils had largely been solved and we could then say with this knowledge at his disposal that the clayland farmer need have no more failures than farmers on other and less obdurate soils.

During the period up to 1944 the increase in productivity of Drayton grasslands was very great. The 1944 leys were many times more productive than the derelict wastes of 1940. These new leys were shown to be capable of fattening both Hereford steers and sheep to prime condition. A Clun flock was kept, and good lambing results were obtained. This was on land that between the wars was reckoned to be well-nigh useless for feeding livestock. Its reputation locally was bad; the name of "Drayton Bushes" still survives. Although no longer applicable, the name was apt enough up to 1940.

The year 1945 saw the beginnings of a change in Station policy. Our terms of reference then gave emphasis to long-term experiments and fundamental research into grassland problems. There was doubt in some minds whether these heavy clays would lend themselves to detailed research and experiment. Any real difficulties have, however, been overcome and the Station is now on a full research basis. The problems of grassland improvement are of supreme importance in the drive for increased food production. Grassland is the basis of our livestock industry, and at all points the call is to step up yields and increase carrying capacity. A proper appreciation of how to grow good grass is fundamental to all this. While its work can be subdivided into several parts, the Station as a whole is concentrating on the all-important problem of extending the grazing season over as many months of the year as possible. This problem is at the very heart of the farming industry. Every week during which the farmer can allow his livestock to support themselves out-of-doors on an abundance of nutritious herbage contributes to the cheapening of production costs. Extending the grazing season cuts down labour and muck carting. Stock do better out-of-doors and are generally healthier as long as they have full stomachs.

The Summer Gap The Station is initially concerned, therefore, with new techniques designed to produce more grass at all seasons of the year, but equally it concerns itself with problems connected with utilization of the grass when grown. Characteristically, grass production is a seasonal affair. As with every other crop, its productivity is strongly influenced by climate, especially temperature and rainfall. The normal curve of grass production shows a large peak in spring and early summer with a secondary, but quite definite, peak in late August and September. There is a period of low production in July-August and a cessation of growth from the autumn to early spring. One problem which faces the agronomist is to investigate means of smoothing out some of the major inequalities in the rate of growth of the grass-legume crop. Much can be done by using special-purpose seeds mixtures, appropriately managed and fertilized so as to provide for the low production periods. The summer gap is fairly easily filled by such mixtures as those based on cocksfoot with lucerne, or in some districts cocksfoot with the clovers. Again the mixture based on leafy timothy,

meadow fescue, cocksfoot and white clover can be made productive right through a normal dry summer. Type mixtures are as follows:

(A) Mixed Grasses with Clover	*lb. per acre*
Timothy S.48	5
Meadow fescue S.215	5
Cocksfoot S.37	5
White clover S.100	2
Total:	17

(B) Lucerne Mixture	*lb. per acre*
Lucerne (Provence or Grimm) ..	15
*Cocksfoot S.37	3
White clover S.100	½
Total:	18½

Another very good way of filling the summer gap is to plant new seeds in spring without using a cover crop—that is, to sow the seeds mixture on clean land and to graze the new sward as soon as keep is available and to go on grazing on the "off-and-on" system right through the summer months. Apart from the excellence of July–August grazing made available in this way, the method of direct sowing is one of the best means of ensuring first-class establishment in all manner of weather conditions and throughout the length and breadth of Great Britain.

The Winter Gap So much for the summer gap. There remains the more difficult winter gap from October to April. There will always be need to conserve the high quality herbage grown in the early summer for feeding back during the winter as hay, silage or dried grass. The winter season can, however, be shortened appreciably and the need for hand feeding thereby lessened by growing out-of-season keep. Early bite in the spring can be brought forward quite a month by the use of special leys rested over the winter and given a dressing of nitrogen in late February or March. Leys based on ryegrass will normally make earlier growth than any others, but, if specially treated, cocksfoot, meadow fescue and even timothy dominant swards can be made to provide very early keep, particularly if rested during the autumn and winter. Providing early keep in this way is obviously valuable; but more than this can be done.

Young vigorous leys based on the leafy strains of ryegrass, cocksfoot and others will provide good growth well into November if they are well treated, which includes a September rest after a dressing of nitrogenous manure in late August. So by arranging for late as well as early bite from high-class leys, the winter foddering period is shortened to the period mid-November to March in lowland districts.

With regard to the remaining winter months, a proportion of the food requirements can still come off grass grazed *in situ*. The mixtures quoted above can help. That based on mixed grasses and white clover and containing S.48 timothy, S.215 meadow fescue (Mixture A) will remain abundantly winter-green if it is rested from early September onwards and used December-January. The lucerne ley with its companion grasses (Mixture B) will also provide good feed during this period. Lucerne leys should always

* In districts with an annual rainfall above 28 inches, either leafy timothy or meadow fescue should be substituted for cocksfoot.

be rested in September and October, and the lucerne allowed to die back. This usually leaves a wealth of green grass leafage which *must* be grazed back hard during the winter (December-March).

Winter Grazing Experiments At the Station we have found that certain grasses when grown in widely spaced drills (about 2 feet apart) will produce a mass of foliage which will retain its winter greenness, quality and palatability right through the winter period. The most useful strains for this purpose appear to be cocksfoot S.143, timothy S.48, S.50 and S.51 and meadow fescue S.215 and S.53. Other grasses are under trial, and the following show some promise—ryegrass S.23, tall fescue S.170 and meadow foxtail S.55. It is possible, too, that such grasses as winter-green types of tall oat, S.59 red fescue, *Poa pratensis* and *Poa trivialis* may be found useful for this purpose. The whole technique of growing grass in widely spaced drills (which can be intercultivated during the spring and summer) seems clearly to warrant detailed investigation.

Throughout the winters of 1947–48 and 1948–49 two-year-old Hereford-type bullocks have been kept out on grass and have done well. These bullocks have been on the usual experimental plots during the summer and autumn, but have had access to grass rows (cocksfoot S.143) from January to March, when they again returned to the summer experiments. During 1947–48 winter we carried 17 bullocks on 14 acres of cocksfoot rows from January 9 to the end of March. Hay was fed at the rate of about 10 lb. per head per day, and the bullocks more than held their own. The trial was repeated on the same acreage and with the same number of bullocks during the winter of 1948–49, but this time no hay or other fodder was fed. The bullocks again more than held their own; in fact during the first five weeks (early January to mid-February, 1949) the 17 bullocks put on over 1 lb. live weight per head per day on the average for the whole herd.

Apart from the well-being of the stock, two other points emerge: (1) the cattle, when grazing, walk and excrete *between* the rows of grass, and therefore do not spoil the herbage by treading; and (2) there is surprisingly little poaching of the land. In fact there is no real poaching even in the wettest of weather, and that on the very heavy and sticky clays with which we are dealing. This is an interesting practical point which needs to be studied in greater detail to seek the answer to the question *why* there is so little poaching. The winter grazing experiments in question have been carried out in two contrasting winters. At Drayton the winter of 1947–48 was exceptionally dry in its first half (October to early January). This was followed by an extremely wet January and February. By contrast, the early winter (October–December) of 1948–49 was very wet, while the rainfall in January–March, 1949, was below average. In neither winter did we find any undue poaching of the land between the cocksfoot drills. In both years leys in the normal closely grazed winter condition were badly poached when heavy cattle were turned out on them.

Better Leys on Heavy Clays The results from these and other experiments conducted at the Grassland Research Station are beginning to bear fruit and are showing the way to better and more efficient production on our heavy clays. Many farmers in the Midlands are now beginning to think in terms of new cropping rotations which are designed to reduce labour demands to the minimum, while maintaining the highest possible standard of soil fertility and crop

yield. Traditionally, the clayland farmer working on a ley system of farming reckoned that he required one man per 40–60 acres. The tendency now is to think in terms of one man per 100–120 acres.

One leading ley farmer in the Midlands (Mr. Maurice Passmore of Wormleighton, Warwickshire), farming on heavy lias clay, does so using the four-year ley with two or three white straw crops (winter wheat and winter oats chiefly). This represents a six–seven course rotation. The traditional labour-absorbing rootbreak and the bean crop are now omitted, and in proportion as the leys are productive *throughout their whole duration*, so do the corn crops yield at high level. Following the ploughing and cultivation of his leys, Mr. Passmore finds he can grow an average of 7–8 quarters (say 32–36 cwt.) of wheat per acre. His problem is to find the right variety of wheat and oats which will not become lodged at harvest. The modern French wheats, together with S.172 winter oats, have largely solved this problem for him.

The livestock policy associated with such a rotation can be of the simplest. Mr. Passmore, being a livestock enthusiast, not only follows his own inclination but also fits in with current national demands when he rears cattle and sheep and fattens them in due time on his leys. He uses many of the leys for seed production of pedigree grasses and clovers. He has a proportion of grasses (cocksfoot and timothy especially) in widely spaced drills. He takes seed from them in summer, rests them during the autumn and grazes sheep and cattle on them in December to February. By so doing he shortens the winter, reduces labour demands, and cuts his costs of production to the minimum.

This example is quoted to show how the modern farmer is quickly taking advantage of the lesson of current research work. At one time research workers tended to frown on such tendencies as these, but early practical tests will sometimes provide valuable additional data which the investigator can use to develop his work.

FRUIT-GROWING IN THE WEST OF ENGLAND

ERIC W. HOBBIS, B.Sc., N.D.H.
Long Ashton Research Station, Bristol

FRUIT-GROWING in the West of England is mainly concentrated in Worcestershire and the surrounding counties of Herefordshire, Warwickshire, and Gloucestershire, but Somerset, Devon, and (to a less extent) Monmouth also account for considerable acreages of both hard and soft fruits; there have been relatively small but more recent plantings of fruit in Cheshire, and small areas, mostly of older planted orchardings, also occur in Shropshire and Staffordshire.

Historical Aspects Fruit production in the West probably had its early beginnings in and around Evesham, where, in A.D. 907, Benedictine monks came over from the Continent of Europe and estab-

lished a Benedictine abbey in Evesham. The Benedictines were skilled gardeners and fruit growers, and probably the vine was introduced to local culture for the purpose of wine-making. In time, however, and no doubt as a result of experience, the grape gave way to the apple and pear, and cider and perry took the place of wine; orchards were planted in the immediate vicinity of Evesham and, later, of Pershore.

Cider and perry orchards seem to have become well established in the eighteenth century and the beverages enjoyed a wide reputation, but the orchards remained local in extent and comprised little other than vintage varieties. Even in 1870 practically no fruit was grown for sale outside the area, but by 1880 a new era in orcharding was opened, and no account of fruit-growing in the West would be complete without at least some mention of those enthusiasts who did so much to provide the foundations of modern fruit-growing practice

The name of Thomas Andrew Knight comes at once to mind. Born in 1759 at Wormsley Grange, a few miles north-west of Hereford, and not far off the Watling Street, T. A. Knight became an experienced farmer and a great authority on fruit-growing. His writings influenced the trend of fruit tree propagation and planting not only in the West of England but over the whole country. He raised many new varieties of different fruits ; cherries perhaps received most attention, and several varieties still being produced commercially perpetuate Knight's name, including Elton Heart, Knight's Early Black, and Waterloo ; the last of these, introduced in 1815, is as widely planted as any cherry in this country and is also planted in Canada and the U.S.A. Knight also experimented with strawberries, and "Elton," raised in 1827, was, until the early years of the present century, a well-known standard variety in English fruit gardens.

It was in 1804 that John Wedgewood, of Betley, Staffordshire, had the idea of establishing a society for the improvement of horticulture, and the Horticultural Society (now the Royal Horticultural Society) was born of his efforts. T. A. Knight contributed numerous papers to the new Society and was its President for the twenty-seven years immediately prior to his death at Downton Castle in 1838.

The spirit of Knight lived on in others who followed him in the western counties, and of these mention must be made of William Crump, who was born at Pontesbury, Shropshire, in 1843. A man of great horticultural experience, he was gardener at Madresfield Court, near Malvern, Worcestershire, from 1883-1919. Crump devoted much time to disseminating knowledge by lectures, student classes and demonstrations of improved methods of fruit-growing—a branch of horticulture of which he was passionately fond. He died at the age of 90 after a long career replete with contributions to his beloved horticulture. The delicious, late-keeping dessert apple, William Crump (Cox's Orange × Worcester Pearmain), perpetuates his name. Many other names could be added to the list of West Country growers who have added to the store of knowledge of fruit-growing and whose successes have had a lasting effect on the industry.

The establishment of dessert and culinary plantations arose as a natural development from the old-time cider and perry orchards of the general farm. In the West Midlands the new plantings were pioneered by Mr James Best, of the Stocks Farm, Suckley, on the Worcestershire-Herefordshire border, who set out a commercial orchard in 1881. His example was followed by a Mr. John Riley, of Putley Court, near Ledbury, in Herefordshire, and later by Mr. Paget Norbury, of Sherridge, near Malvern, who was also the first to grow loganberries commercially in this country. The first commercial plantation of plums in this country was started in 1881 at Church Lench, near

Evesham, with Pershore Yellow, and in later years a great industry developed around this variety.

Famous Nurseries and Varieties The West Country has also produced some famous nurseries which flourished during the nineteenth century and in the early years of the present century, when fruit-growing in the many private gardens of the country, both in the open and under glass, was in its heyday, and commercial production was beginning to expand.

The famous Smith's Nurseries of Worcester, established about 1800 and which once covered more than 150 acres, exported plants to all parts of the world and especially to North America. These nurseries also produced plantsmen who were sought after throughout the country because of their training in an establishment which produced an amazing range of horticultural plants, including fruit trees. The apple Worcester Pearmain, raised by a Mr. Hale, was introduced to commerce in 1874 by these famous nurseries, and, until a few years ago (at least), the original Worcester Pearmain tree was still in existence in a garden at Swan Lane, Worcester.

The King's Acre Nurseries of Hereford, established in 1785, gained a high reputation for their fruit trees and for new varieties which they introduced, notable among which was the King's Acre Pippin apple. These nurseries greatly influenced planting trends and cultural methods throughout the West of England.

The Pershore Yellow Egg plum has been planted far and wide since its discovery, in 1822 or 1827, as a chance seedling in Tyddesley Wood, near Pershore, by a certain George Crooke, a gardener and the licensee of the Duck Inn, Pershore. The plum-growing industry of the Vale of Evesham owes much of its development to the merits of this variety and, although overplanted in recent years, Pershore Yellow Egg is still used in enormous quantity by the jam and canning industries.

Another seedling plum which has attained great popularity in the Pershore and Evesham areas is the Pershore Purple, or Martin's Seedling as it was originally called. It was raised by a Mr. Martin, of Drakes Broughton, about 1877, and quickly became established as a popular market variety. More recently a strain of black currant, Hilltop Baldwin, propagated at Hilltop Farm, Ledbury, has proved its value by its cropping capacity and yield of juice of high vitamin C content.

Such is briefly the outline of some of the early beginnings of an industry which now holds an important place in the economy of West Country agriculture.

Development of Fruit-growing in the West Many acres of grass orchards planted seventy and more years ago remain. They are typical of the early attempts at the field culture of apples and pears, when farmers planted standard trees mainly to produce fruit for cider and perry. In time, as cider and perry became less customary as farmhouse drinks and ceased to be part of the workers' wages in kind, the newer plantings changed to culinary, dessert, or "dual-purpose" kinds which the farmer could sell at higher prices than were obtained for cider fruit. Most of these grass orchards, however, were run as sidelines on general farms; the welfare of livestock grazing beneath the trees was often the primary concern, and the fruit trees received little attention, other than protection from grazing animals.

The planting of top fruits of dessert and culinary kinds as a special venture ushered in a new era of fruit-growing when, on some farms, fruit re-

placed livestock as the primary consideration. For apples and pears the bush type of tree appealed to the grower because it was more manageable for most cultural and harvesting operations and came into bearing earlier than the standard tree.

Plums continued to be grown on high-stemmed trees, but the half and three-quarter standards replaced the older 6-foot trunk and are still popular today. Cherries, however, are still grown as standards in grass, and the sward is close-grazed by young cattle and sheep. In a few instances only have shorter-stemmed trees been introduced and grass kept short by mowing.

In the great market-gardening areas of the West, around Evesham and Pershore in particular, fruit-growing was developed as an adjunct to market gardening. Trees, mainly plums, were planted fairly closely in wide rows (22 yards was a popular distance), the land between being used for market-garden crops and the trees acting as shelter belts. The market-gardening areas led also in the growing of strawberries and bush fruits such as gooseberries, currants (red and black) and, to a smaller extent, raspberries. The underplanting of tree fruits with bush fruits and strawberries took the place of market-garden crops on some farms, and underplanting in this way gradually became common practice on the newer established fruit farms.

The distribution of fruit-growing in the western counties has been influenced by centres of early production (e.g., Vale of Evesham) by proximity to markets, and suitability of soil. Plantings have tended to scatter as transport has improved and suitable soils and sites not subject to spring frosts have been found in new areas.

For those interested in statistics the following Table, based on the 1944 Fruit Census of the Ministry of Agriculture and Fisheries, gives a picture of the extent of the fruit-growing industry in nine of the western counties of England. The counties are arranged in alphabetical order for convenience. The soft fruit acreages for each county are stated, but for top fruits actual tree numbers are given.

West Country Fruit Census, 1944

County	Soft Fruit *acres*	Apple Trees			Plum Trees	Cherry Trees	Pear Trees
		Dessert	Cooking	Cider			
Cheshire	205	83,400	70,500	100	14,800	700	34,700
Devon	553	167,700	278,800	918,700	67,300	6,800	19,000
Dorset	59	33,100	19,600	42,700	5,100	300	3,400
Gloucester	328	114,700	200,400	115,600	274,900	8,400	41,200
Hereford	732	181,500	191,900	351,200	162,800	18,500	25,700
Monmouth	52	26,700	32,300	35,900	11,500	1,400	7,800
Shropshire	36	19,000	29,100	29,400	35,800	3,200	5,200
Somerset	315	152,700	165,200	558,000	28,400	900	12,500
Worcester	1,893	205,700	304,900	76,500	1,249,100	63,000	126,900

Rainfall has had an important influence on planting in the West. Roughly speaking, and ignoring hill and mountain regions, the western borders of Cheshire, Shropshire and Monmouthshire are within the limit of the 35-inch rainfall. East of these borders the annual rainfall varies from 25 to 35 inches a year, increasing from east to west, with one or two areas, e.g., south Worcestershire, having less than 25 inches. To the south and south-west, in Gloucestershire and Somerset, the rainfall generally exceeds 30 inches, and in many parts of Devon it is 40 inches or more.

The newer commercial top fruit plantations have developed mostly in the lower rainfall areas, and for this reason commercial top fruit plantations are fewer in the south-western districts, although excellent fruit is grown in

many of the lower rainfall areas of the south-west where soils are suitable. High rainfall (35-40 inches), however, does not affect soft fruits in the same way, and a large acreage, especially of black currants and strawberries, has been grown for many years in the south-west.

The soils of the western counties, as elsewhere, are very varied. The heavy clays of lower lias origin in the Evesham area support a great acreage of plums; heavy loams derived from Old Red Sandstone in west Worcestershire, Herefordshire, and sandy loams of this formation in the Ross area, are planted with a whole range of top and soft fruits; and lighter soils of New Red Sandstone origin east of Exeter and in north Worcestershire grow excellent apples.

Present-day Conditions Changing conditions, particularly in the last twenty years, have been met by the adoption of new methods. The mainstay of commercial top fruit and soft fruits of high quality in the western counties is now the specialist fruit farm, both small and large, or the mixed farm or holding with a special orcharding section.

The fruit for cider and perry is still produced, in the main, in the numerous small (and often very old) cider orchards on mixed farms scattered over the whole area of the West. But here, also, the trend is changing, and cider orcharding is entering upon a new phase as a result of research findings and the demand for cider of high quality. For future plantings, varieties which make good orchard trees and yield fruit of high vintage quality are being propagated and planted to meet the demands of the trade. In a few instances the traditional mixed orchard of standard trees in grass, grazed by livestock, has been replaced by plantations of shorter-stemmed, bush trees of a few specially favoured varieties, established in arable conditions, but to be grassed down in later years and managed by constant mowing in place of grazing by livestock

The commercial fruit farm also has undergone revolutionary changes in methods of cultivation. The necessity to do more of the work by machines has led to the adoption of wider planting distances for plantation trees. Undercropping of top fruit with soft fruits and "floor" cropping with market-garden produce, with its attendant increase in hand labour and difficulties of efficient pest and disease control, have been superseded by the specialist one-crop plantation wherein management can be of the highest order and costs lowered. Increasing numbers of established apple plantations are being put down to grass, to be mown frequently throughout the growing season with the gang mower, the cuttings are left on the ground to decay and so help to build up the organic matter content of the soil and to return to it nutrients in water soluble form

Worcestershire produces much more top and soft fruit than any other county. Of soft fruits alone it has approximately 2,377 acres, which is almost equal to the total acreage in all the other above-mentioned eight western counties. Similarly with dessert and culinary apples, pears, plums and cherries, Worcestershire is the predominant fruit growing county of the West.

Of the areas specially concerned with particular crops, the Teme Valley and surrounding country, the Bewdley district, and the country around Ledbury and north of Malvern are well known for their apple and cherry production; plums are grown extensively in the Vale of Evesham and around Pershore; plum and mixed fruit plantations are found around Cheltenham, and the Cheddar Valley of Somerset and the Tamar Valley on the borders of Devon and Cornwall are famed for the production of early strawberries Damsons are grown in considerable quantity along the Worcestershire-

Shropshire border, where they are a feature of the hedgerows on many of the hillside farms and on land which might be considered "marginal" from the fruit-growing point of view.

Cider orcharding is scattered throughout the western counties; Devon, Somerset, Hereford, Worcester and Gloucester, in order of acreage and number of trees, provide the greatest bulk of fruit. Well-defined areas of cider fruit production exist around Hereford, in the Martock area of Somerset, and in the country east of Exeter. Dorset, Monmouth, and Shropshire grow relatively small acreages, and in Cheshire cider orcharding is negligible.

Fruit-growing in the West now caters for the needs of the fresh fruit market, the jam-maker and canner, and also the cider industry. The processing of fresh apple juice has latterly added to the demand for milling apples, and some commercial fruit farms are planting vintage varieties of apple to aid the disposal of cull fruit and also to supply the needs of the modern cider and fruit juice industries.

Considerable expansion in the growing of black currants has taken place during recent years in Devon, Somerset, Gloucestershire and, to a less extent, in Monmouth. Many acres of this fruit have been planted since the war under long-term contracts with the processors.

The West Country grower has shown himself capable of growing fruit in variety and of high quality; the West of England is one of the mainstays of the fruit-producing and fruit-processing industries of this country and contributes in no small degree to the employment and well-being of the agricultural community.

CIDER AND THE WEST COUNTRY FARMER

Professor B. T. P. Barker, M.A.

Emeritus Professor of Agricultural Biology, Bristol University

FOR many centuries cider-making and the culture of cider apples have been distinctive features of West Country farming. It seems probable that the introduction of cider into this country was one of the results of the Norman invasion, for the earliest record of the beverage here seems to be 1205 A.D., when it was reported that two hundred Pearmain apples and four hogsheads of wine made from the Pearmains were paid yearly as tenure at Redham and Stokesley in Norfolk. Since estates in various parts of the West Country were granted to some of the Norman barons by William the Conqueror, it is likely that the latter planted orchards of cider apples on their farms with trees brought over from Normandy, where at that time cider was already a drink of repute. It is obvious that conditions in the western counties were particularly favourable for vintage apples, for in due course at least one orchard was established on most farms, while in no other part of the country—except, possibly, Norfolk—did cider apple-growing make any real headway.

To the end of the nineteenth century the position remained materially unchanged. Most West Country farmers still maintained their cider orchards, making from the apples cider for the farmhouse and farm labourers and selling any surplus locally and to the relatively small number of cider drinkers in other parts of the country. Nevertheless, the vast changes which took place during that century—especially in the directions of scientific

knowledge, improved transport and the development of advertising—were creating conditions destined to alter fundamentally the position of the average farmer in relation to cider-making and of the beverage itself as an article of commerce.

The first fifty years of the present century in particular have seen cider transformed from a typical farm product of the West Country to a factory-made article more or less standardized in character and rapidly attaining world-wide distribution. Factories are springing up in all the leading apple-growing districts in England and no longer is it the cider apple proper that is used exclusively for the manufacture of the drink. A substantial industry, with an annual output of twenty million gallons or more, has been created. It has its own organized National Association and also a centre for scientific research at Long Ashton*, aided financially by Government and County Council grants.

It is inevitable that the changed conditions have created problems associated with cider production very different in character from those of the days when cider was primarily a farm-made product. Those which concern the farmer more or less directly will be considered here, and methods by which the needs of the industry can be met will be indicated.

The Farmer as Cider-maker It is clear from what has already been said that the recent evolution of the industry has, broadly speaking, left the farmer as the grower of the raw material and the factories as the centres of manufacture of the product. There still remains, however, a comparatively small number of farmer cider-makers, and this group can be of undoubted benefit to the industry as a whole, provided its aim is to fill the part which is particularly suited to the relatively small producer. Growing most of the fruit used by themselves, these farmers have the opportunity, denied to the large factories, of an intimate knowledge of their raw material and how to use it to the best advantage. Thus they should be able to produce a grade of *de luxe* cider, capable of commanding the highest prices, more easily than the larger producers handling much greater tonnages of fruit, which under present conditions are necessarily of very mixed character as regards vintage quality. The equipment required for the production of cider of that class need not be very elaborate or costly, and technical advice can be obtained from the Long Ashton Research Station.

Unless high vintage quality is their objective, it is likely that sooner or later the farmer cider-makers will find themselves unable to compete in the open market with the factory-produced article and will be driven to follow the lead of most other farmers and sell their fruit to the factories It is significant that when a farmer has taken a genuine interest in his cider-making and has kept in touch with modern improvements in methods of production, he has usually managed to sell his output without difficulty at a remunerative price, and not infrequently ends by expanding his operations to a substantial and successful business. Several well-known firms have originated in that way.

The Farmer as Fruit-grower As, however, in most cases the farmer's concern with the cider industry today is primarily that of a supplier of apples, it becomes more and more important that, with the industry progressing rapidly, he should provide material of the right kind for its needs.

---

* See article by Professor T. Wallace, p. 170

At present the situation in this respect is extremely unsatisfactory, largely owing to the radical changes brought about by the growing popularity of cider as a drink among all classes throughout the country. The type of cider most in demand is altogether different from the traditional dry, rough, and very variable potent liquor favoured hitherto by the seasoned cider drinkers on the farms. The first essentials are that it must be reasonably uniform in character, pleasing to the palate—usually with some degree of sweetness—and attractive to the eye in clarity and colour. To attain these essentials the factories are working under a heavy handicap in having to use raw material of a completely mixed character and variable quality. Until more suitable fruit is available, they cannot approach the peak of vintage merit which high-grade vintage apples can yield with the aid of modern technique.

The position is fundamentally the result of the defects of the existing farm orchards. Most of them were planted long before the cider industry in its present form had developed. These old orchards, which still provide most of the cider apples used by the industry, contain innumerable varieties. Many of them are chance seedlings, either unnamed or known only by some local name; in most cases evidently they have not been considered worth further propagation. Little is known of their vintage value, and the majority of those already examined can be classed as very inferior in that respect. Of the remainder, most have a very local distribution and their selection for culture does not appear to have been made with much regard for either vintage or orchard quality.

A relatively few varieties have become more widely distributed, mainly as a result of their obvious merits. Until recent years their range did not as a rule extend far beyond the county of origin. Thus, for example, varieties such as Foxwhelp and White Norman were grown extensively in Herefordshire and on the borders of adjacent counties, Chisel Jersey and Morgan's Sweet in Somerset, and Sweet Alford and Woodbine in Devon. In only one instance—Kingston Black—was the distribution general throughout the West Country, and that was obviously due to its outstanding vintage quality.

Thus the available raw material consists principally of indifferent quality fruit, although there is a small nucleus of high-grade varieties of rather limited distribution.

Varieties to Grow Today the cultivation of the better county cider varieties is gradually extending. This is largely the result of the establishment of a series of trial orchards over the whole of the western counties by the Long Ashton Research Station. The trial orchards planted first (forty years ago) have now matured, and the respective County Horticultural Officers have been able to demonstrate the results to farmers of their individual counties. From one of the trial orchards in Hereford data on the cropping performance and financial returns of the respective varieties and on the costs and results of spraying over a period of sixteen years, have been recorded by Mr. C. Savidge, until recently the County Instructor. These appeared in summarized form in the *Annual Report of the Long Ashton Research Station for* 1946 as the most complete record so far published on cider orchard yields and finance.

Another direct result of the widening of the distribution of some of the best varieties has been the compilation of a list of varieties which, after extensive trial, can be recommended for orchard planting, both in respect of orchard performance and vintage merit. The list, with relevant data on each variety, has been prepared by the Cider Advisory Committee of the Long Ashton Station and will be supplied on application to the Station. The selected varieties cover in their ripening periods the whole of the cider-making season.

Concurrently with these efforts to rectify past mistakes in planting inferior varieties when new orchards and tree replacements were taken in hand, a quicker result in the production of crops of the recommended varieties is being aimed at by regrafting suitable established trees of low-grade sorts in the existing orchards with those of higher grades.

Along these lines the standard of quality of the raw material for the industry can be raised to a striking degree during the course of the coming generation, and an enhanced return from the orchards assured to the growers by heavier crops from healthier trees.

It must not be assumed, however, that the raw material problem is to be solved merely by growing high-grade varieties. What the industry needs to enable it to produce the desired types of commercial ciders with a sufficient degree of uniformity is a fruit supply comprising a limited number of varieties with the necessary tonnage of each. In addition there must be a suitable balance in the quantities of fruit of each of the main classes of cider apples, namely, the sharp, the sweet, and the bittersweet.

The pressing need of the moment is for apples of the last two classes, because cull eating apples of high acidity have to be used to offset the existing shortage of cider apples proper. It is imperative, too, that the apples should reach the factory in good condition; it is impossible to make the best cider from unsound or unevenly ripened fruit.

It seems, therefore, that some form of co-ordination between the cider-makers and the growers will be required to ensure these essentials, and crops must be timed to give a steady flow of properly ripened fruit to the factories throughout the whole of the cider-making season in order to avoid undue congestion at any period.

New Orchards Wanted The present time is particularly opportune to improve the fruit supply position. The acreage of farm orchards has fallen from over 110,000 in 1895 to less than 58,000 in 1945, while Ministry of Agriculture statistics show the present average crop yield to be only about 1¼ tons per acre. This decline has caused a very serious shortage of cider apples for the industry, which has consequently been obliged to make use of a large tonnage of commercial cull apples of low vintage quality.

Thus there is an immediate need for planting new cider orchards on a very extensive scale. If the usual type of standard-tree orchard is planted, there must be a delay of at least twenty-five years before crops of material tonnage per acre are obtained. Hence experiments were started by the Long Ashton Station fourteen years ago with the object of speeding up cropping, the trees being grown in bush form instead of standards. The results have proved that with suitable varieties and under suitable conditions crops of about 5 tons per acre can be reached by the seventh year after planting—a saving of about twenty years, as compared with the standard tree method. Details of the method are given in a booklet issued by the Long Ashton Station.

For most farmers the bush method in its present form is not so well adapted as the standard orchard, being more on the lines of commercial apple culture, although differing from this in that the plot is grassed down a few years after establishment. It is worth consideration by commercial apple growers for any marginal land they may have on their farms, since they already possess the necessary equipment, such as cultivators and spraying outfit. It would also give them a better chance of selling their culls to the cider factories by enabling them to offer cider fruit for blending purposes.

This method is already attracting the attention of a new class of grower, who wants to grow apples but lacks the necessary capital or knowledge for a venture with the more costly and difficult commercial apple culture. Thus a group of specialist cider-fruitgrowers may arise.

It is significant, too, that several of the professional cider-makers have begun already to grow cider fruit, either directly or through the agency of subsidized growers. Starting in the first instance with the Standard Tree method, some have recently turned to the Bush Plot method for quick crop returns.

There are definite signs that the post-war recognition of the alarming decline in cider apple production and the recent efforts to increase the supply have stimulated a widespread effort to remedy the position. A large number of orders for young trees, beyond the capacity of the nursery trade to meet immediately, have been placed. In addition, the regrafting of unprofitable trees is being undertaken extensively, and one firm alone reports that over 10,000 scions have been supplied by it for the season's grafting.

Thus, while the industry for the next decade or so may still have to contend with its most serious present problem—the shortage of cider fruit proper—there seems a reasonable probability that ultimately this will be overcome and that the vintage quality of the raw material will be far better as a whole than ever before. With advances also being made constantly in the technique of cider-making, and the market for the drink widening steadily, the future for the typical West Country product so closely associated with the agriculture of that area seems full of promise.

HOP-GROWING IN THE WEST MIDLANDS

E. H. Wilkinson
Newnham Bridge, Tenbury Wells, Worcs

HEREFORDSHIRE and Worcestershire comprise the West Midland hop-growing region and can be defined more precisely as the area enclosed by a line joining Hereford, Leominster, Tenbury Wells, Worcester, Ledbury and Ross-on-Wye. The survival of hop-growing in this region can be attributed to the deep, rich soil (mainly of Old Red Sandstone), the availability of local skilled labour, and the availability of pickers from nearby South Wales and the Black Country.

It may surprise many to learn that out of 22,787 acres growing in England in 1948, 6,937 (about one-third) are located in the West Midlands—4,737 in Herefordshire, and 2,200 in Worcestershire.

Cultivation on the Worcester System

Four main varieties are grown: namely, the Fuggle, Bramling, Early Bird, and Mathon. The Fuggle occupies about 75 per cent of the acreage and, although not of such high quality as the other three (known collectively as Goldings), is less particular as to soil type and flourishes in the heavy soils of Herefordshire. The choicer Goldings prefer lighter, well-drained soils which permit full development before ripening, and experience has shown the deep alluvial deposits of the Teme Valley to be ideal for their production.

The pioneer work of Mr. James Nott of Tenbury Wells has encouraged the planting of certain seedling varieties raised by Professor E. S. Salmon, and Brewer's Gold, Bullion and Northern Brewer have given encouraging results.

Propagation is carried out vegetatively by "strap-cuts" taken each March from established plants. During the past two years the writer, using tested East Malling clonal strains of Early Bird, Mathon and Mosaic-free males, has attempted, by layering and softwood cuttings, to propagate true-to-type, disease-free plants which the indiscriminate propagation from commercial yards will not guarantee. The results are most promising.

The hop plant is dioecious, and to obtain full development of the cones males should be planted at the rate of 20 per acre. Recent work has classified males into Mosaic "tolerant" and "sensitive" groups, each of which has been further subdivided into early, midseason, and late-flowering types. Growers can now plant a range of males to ensure complete pollination and eliminate the risk of disease transmission to female plants.

The normal planting distance is 3 feet 3 inches in rows 8 feet 6 inches apart, with posts at 15-20 feet intervals supporting a permanent system of overhead wires 14 feet high. With the aid of a long pole, two strings (coir yarn) are extended from each plant to the overhead wires in a continuous run. One man can string 1½ acres per day, using approximately 12 miles of string.

This lay-out is known as the Worcester system. It requires 1,500 plants per statute acre and permits cultivation in one direction only, but renders training and spraying comparatively simple.

Hops receive generous manuring, and it is usual to apply the following, in rotation, over a three-year period : foldyard manure up to 20 tons per acre, shoddy at 2 tons per acre, and ground limestone at 2 tons per acre. During each growing season these are supplemented by applications of balanced fertilizers, but the quantity of nitrogen used is less than that recommended for Kentish soils.

During the previous winter soil is ploughed up to the stocks, and in late February is ploughed back into the alleyways. In March each plant is "cut" by removing the soil immediately around the stocks and cutting the bases of the previous season bines hard back to the crown (these bine bases are the "strap-cuts" used for propagation). In April many shoots or bines grow from the crowns, and in early May each string is furnished with two bines trained in a clockwise direction, the remainder being eliminated. The bines climb up the strings naturally until they reach the top wire—normally by late June. The leaves and lateral growths are then stripped off the basal 4 feet of each bine in gradual stages (a process known as "belting") to facilitate circulation of air and to prevent the upward spread of pests and diseases.

The soil is constantly cultivated with deep scuffles, followed by a Cambridge roll to eliminate weeds and promote a deep, moisture-retaining tilth. After "belting," a ridge of soil some 9 inches high is moulded to the bases of the bines.

Pest and Disease Control West Midland Fuggle growers generally prefer to eliminate pests and diseases by powdering. The hop-damson aphis (*Phorodon humuli*) is controlled with 4 per cent nicotine powder, Mould (*Sphaerotheca humuli*) with flowers of sulphur, and Downy Mildew (*Pseudoperonospora humuli*) with copper. Goldings, however, are very susceptible to Downy Mildew, and spraying is favoured by growers of these varieties. HETP was used as an insecticide against aphis in 1948, and had the added advantage of controlling red spider, which is a menace in some hop-yards.

The "fluctuating" form of Verticillium Wilt (*V. albo-atrum*) is present in a few West Midland yards, but the dreaded "progressive" form, causing such serious losses in the south-east of England, has not been recorded.

Virus diseases are the greatest cause of loss to West Midland growers. Nettlehead, producing leaf-curl and sterility, attacks all commercial varieties and males. It is frequently found causing marginal infection of yards following the line of hedgerows, trees and ditches. Mosaic attacks Goldings and some males ("sensitives"), but is carried without symptom expression by the Fuggle, most Wye seedling varieties and some males ("tolerants"). It is a lethal disease, killing infected stocks in two years.

Little is known concerning the natural spread of these diseases, but partial control is obtained by grubbing infected stocks as they appear and segregating "tolerant" and "sensitive" varieties. The general impression today is that Mosaic infection is static, whereas Nettlehead is increasing and causing considerable anxiety.

Picking and Drying Picking starts early in September and goes on for three or four weeks. Pickers come mainly from the Black Country, are housed in barracks, and it is usual for one group to return to the same farm each year.

For the grower it is a period of great mental strain, and he must be capable of adapting himself to handle a diversity of events, ranging from strikes and maternity cases, to cut fingers and family squabbles, and, at the same time, preserving an ever-constant vigil over his unpicked fruit crop.

The bulk of the crop is still picked by hand into "cribs" constructed by suspending a canvas cloth over a ridged wooden framework. Pickers are paid by volume, the 1948 prices ranging from 10d. to 1s. 3d. per measure (10 gallons), depending on variety. Eight measures of green hops are placed in "green-sacks" or "pokes" and conveyed to the kilns for drying. A good picker will pick 15 to 20 measures per day. A few growers are now picking their entire crop by machine.

Drying is always done by the grower, the green hops being spread evenly on horse-hair cloths supported on a slatted wooden floor. It is normal to pass fumes of burning sulphur through the hops at the start of drying. A large proportion of West Midland hops are pure air-dried, so that the products of fuel combustion do not come into contact with the hops. Drying takes about ten hours to complete, enabling two loadings in twenty-four hours. The dried hops are carried on to the cooling floor and, when cool, are packed mechanically into long cylindrical bags ("pockets"), so that each holds 1½ cwt. of hops. In this state they are transferred to warehouses, where they are weighed and sampled before being sold to the brewer. The samples are used by the Hops Marketing Board for assessing the price of each pocket.

FARMING IN SHROPSHIRE

J. W. Reid, F.A.C. (Glas.), N.D.A.
County Agricultural Officer, Shropshire

Farming in Shropshire covers a wide range of types, and there is a corresponding range of soils and climate. Indeed there can be few counties where there is so much variety on so large a scale. This is not surprising, for Shropshire is one of the larger English counties and extends to 856,622 acres. Rainfall varies from about 25 inches on the plain to 45 inches in the uplands, and elevation ranges from about 200 feet above sea level to 1,600 feet. The main industry is agriculture, and much of the life and work of the towns depends on the support of the surrounding countryside. The only real industrial area clusters around the Wrekin, and even there agriculture holds its place.

The county sweeps up from the great Midland plain westwards to Wales and southwards towards the Clee Hills. Broadly the river Severn, which flows eastwards from its Welsh source to Shrewsbury and then turns south to leave the county at the Worcestershire border, is the dividing line between the plain and the upland. Among the more noteworthy physical features are the Wrekin, the Stretton Hills, the Clun Hills, the Clee Hills, Wenlock Edge, and the meres around Ellesmere. Grass and arable crops thrive well and seldom suffer seriously from drought, due probably to the greater amount of cloud and the more humid atmosphere than prevails in the south and east of England.

A Grassy Shire Before 1939, apart from the arable area on the plain, Shropshire was traditionally a grass county. War and post-war needs have altered this, although there is still considerable emphasis on grassland. The following percentages of the total area of the county show these changes.

	1939 *per cent*	1948 *per cent*
Tillage	14	27
Grassland	67	52
Rough grazing	7	6
Other land, roads, etc	12	15

Livestock have always been important in the farming economy, and the county is a noted exporter of store cattle and sheep. At the spring and autumn fairs, held at a number of centres, buyers are present from all over the country.

Since 1939 the cattle population has steadily increased, but the decline in the number of sheep, necessitated by circumstances, has as yet only been arrested, and there is much leeway to make up. Pigs are still numerically low but poultry have steadily increased to within measurable distance of the 1939 figures. The following Table shows the position in 1939 and in 1948

	1939 *(thousands)*	1948 *(thousands)*
Cattle	246.7	269.3
Sheep	577.2	339.5
Pigs	111.5	42 5
Poultry	1,528 6	1,486.9

Approximately 10,000 holdings of over one acre make agricultural returns. In such a large county one might expect to find many large farms, but the contrary is the case. Farms under 75 acres represent over 70 per cent of the total and only 3.6 per cent are over 300 acres. Even in the upland areas farms of over 150 acres are the exception. Many of the farms are family concerns, and there are few large units with many employees. One-third of the holdings are farmed by owner-occupiers.

FARMING IN SHROPSHIRE

Although there is great variety in farming practice, three main systems stand out: (a) intensive arable farming around Newport, Wellington, Shifnal, and Bridgnorth; (b) intensive dairy farming in the north of the county, pivoted on Ellesmere and Whitchurch; (c) cattle and sheep rearing in the south and west, centred on Bishops Castle, Craven Arms, and Ludlow.

Arable Farming Arable farming is associated with the more free-working types of soil. The main crops grown are barley, potatoes and sugar beet. Farms are normally larger on this class of land, and many are well equipped with labour-saving machinery. In cereal production, combine drills and combine harvesters are common, and potato planters and lifters and sugar beet lifters are in regular use. Although dairying has been introduced, the winter feeding of cattle and sheep is still the main livestock enterprise. On the lightest soils carrots are grown, but market gardening as such is very limited. Early potatoes are a popular crop and they are usually followed by sheep feed. Although there is much variation, rotations are normally based on three-year leys, and one in fairly general use is potatoes followed by sheep feed, wheat, sugar beet, barley, three-year ley.

The June 4 returns for a 230-acre farm give an idea of the distribution of crops and stock, as follows:

Cereals 47 acres, potatoes 21 acres, sugar beet 20 acres, roots 2 acres, leys 130 acres, permanent pasture 10 acres, cattle 114, pigs 108, poultry 35.

There are nine regular workers.

Fertilizers are used to a notable extent, well above the average for the county, and on the better farms yields per acre in the region of 35 cwt. grain, 15 tons potatoes, and 14 tons sugar beet are the normal expectation.

Dairy Farming Intensive dairy farming is typical of the northern part of the county. It is based largely on grassland, and prior to the war few tillage crops were grown in this area. Heavy stocking is characteristic and, with some exceptions, grassland is generally of good quality. Conditions are ideal for summer milk production, but for winter milk the need for adequate home-grown food is not always appreciated. The making of grass silage is spreading, and this, with the facilities for grass drying available, may well result in a farming policy based on grass for both summer and winter keep. The farm output is concentrated on milk. Before 1939 farmhouse cheesemaking was practised widely and, despite labour and other difficulties, the practice, continued on a small scale during the war, is gaining ground again. A number of milk depots are situated in this area. Pigs were kept in large numbers and, although considerably reduced, their association with the cheesemaking industry remains. Poultry keeping is fairly general and on the eastern fringe of the dairying district it has long been a major enterprise.

On a typical 40-acre holding, at present, tillage amounts to 11 acres, leys to 11 acres and permanent pasture to 18 acres. Livestock comprises 17 dairy cows, 5 pigs and 470 poultry.

There are some 5,500 dairy herds in the county. Of these nearly 400 are attested.

Cattle and Sheep Rearing In the district known generally as south Shropshire cattle and sheep rearing are the major enterprises, although there are isolated pockets of dairying and arable farming. Here is the home of the Clun sheep, and that breed, with its near neighbour the Kerry, tends to dominate the landscape. Often referred to as

hill country, this is not strictly correct, for although much of the land is around 1,000 feet above sea level, and in some cases rises to a maximum of 1,600 feet, it is more truly upland country. In some ways it is unique, for the cultivation of oats, rape, etc. is often pushed successfully above the 1,000 feet level, and the tops of the uplands are often flat and covered with a great depth of very good soil. Welsh mountain sheep are found to a small extent, but crosses with the Welsh are innumerable.

The cattle are mostly Herefords. The cows rear one calf per year, and the prevailing practice is to sell the calf when "three half year" (18 months) old.

Economic conditions have played a great part in the state of farming in this district. For a long time prior to 1939 the industry was depressed, land reverted to bracken, gorse and heather, and farm equipment fell into disrepair. Since 1939, and particularly since 1945, there has been a marked renaissance. Bracken-covered hills are being reseeded and under the stimulus of the Hill Farming Act, where it can be applied, old buildings are being renovated and new ones erected. Many occupiers are carrying out such programmes entirely on their own initiative and without financial assistance.

Around Ludlow and in the lower part of Corvedale grass fattening of cattle is traditional and still remains a noted practice.

As an example of the type of farming carried on in the upland Clun area, the following figures are taken from a farm of 400 acres. Tillage amounts to 85 acres, leys 50 acres, permanent pasture 39 acres, and rough grazing 226 acres. Cattle number 70 and sheep 600.

Difficulties In writing about the farming in a county it is always a temptation to dwell only on the good points. It is true that Shropshire enjoys many natural advantages which help to make it a very desirable county in which to farm, but there are also difficulties. The Severn and its tributaries dominate the drainage of the county and, with the Teme and Onny in particular, can be very unruly at times, so that a good deal of land is liable to flooding. The Strine, Tern and Roden in the arable area flow sluggishly, and drainage of the arable land often presents difficult problems.

Much of the soil requires frequent applications of lime and is low in potash ; on the Old Red Sandstone soils phosphates are deficient.

Opencast coal mining around the Wrekin does not make farming any easier in an area where the soil is already heavy and rather intractable. A number of large areas are fairly remote from railway communications and in the upland districts access to the farms is frequently poor.

Although many water supply schemes have been carried out during the past ten years, supplies are still short in some districts. Most farm supplies are from private sources, since the absence of large towns has not attracted public supplies.

But even with these difficulties Shropshire is a most attractive county in which to farm, and visitors to the Royal Show are certain to find interesting farming features by whichever route they come in to Shrewsbury.

CORVEDALE

T. JESSE WADLOW

Much Wenlock, Shropshire

THE twenty-mile-long valley from Much Wenlock to Ludlow and Craven Arms is known as Corvedale. Strictly speaking, it includes more than the dale of the River Corve, because the source of this little tributary to the Teme (which it joins at Ludlow) is at the picturesque village of Bourton, three miles from Much Wenlock. The valley, however, extends to the southern side of the quaint old town, and the whole of it is in mind when any reference is made to this noted grazing district. About six miles from Ludlow the vale sprawls from the river and a branch of it hugs the northern bank of the valley until it reaches Craven Arms, where the biggest ewe sales in England are held. The name of the district provided the title for Lord Corvedale, the late Earl Baldwin's son, now himself the Earl.

Crops Much of the area is included in what has long been known as the "wheatland" district of Shropshire; this is the origin of the name of a pack of foxhounds, whose master is Miss Frances Pitt, the writer on foxhunting, wild life and nature study. This district is quite distinct in character from the rest of the county. As the term "wheatland" suggests, the land is rather strong and clayey—at least, that description applies to the dale itself and the southern bank of the valley; on the northern bank facing south the land is a medium loam on sandstone rock, "the old Ludlow sandstone rock formation". Although some of the best wheat is grown in the vale, this slope (reaching 900 feet above sea level in places) is eminently suitable for arable cultivation and sheep-farming. The well-known Wenlock lime works are only half a mile or so to the north, but the whole valley, unfortunately, is very deficient in lime, except where heavy dressings have been applied.

In addition to wheat, the district is noted for its livestock, and for the livestock forage it can produce. Excellent crops of clover, grass, and roots (including potatoes and sugar beet) are grown. In a very dry season a view of these crops would cause a countryman from the south or east to stand and stare in wonder. Oats, too, grow and yield well, with much more straw than is obtained on lighter or more southern soils. Splendid crops of barley are also grown, and one large fruit and market-garden farm has been operated successfully. The fact that quite good samples of malting barley are produced regularly at heights of 800 feet and over serves to show how one cannot always follow rules in farming; indeed, in very dry seasons some of the barley grown there actually surpasses that grown in recognized barley-growing districts, as the berry generally comes from the thresher plump and wrinkled, however dry the season.

Livestock Cattle are mostly grazed on the lower parts of the valley. Some of the turfs adjoining the foothills of the Brown Clee must be among the best in the country. The hay produced from them would, I think, be the equivalent of oats—many farmers have never in their lives seen hay like it. Several herds of pedigree Hereford cattle and flocks of Shropshire sheep used to be maintained, but the great depression of the 'nineties caused them to be dispersed, and only one or two remain. "He talked about his pedigree cattle, and the first cow that went into the ring was knocked down for £10," said the old foreman of the vendor at a farm sale of that period.

Before the first world war, large numbers of well-finished fat cattle and sheep were produced and, besides large numbers sold at local towns, many went to Wellington auction by special train every Monday, from Much Wenlock and neighbouring stations—mostly those serving Corvedale. In the winter as many as thirty-five closely-packed trucks have been seen on the train. The meat situation will not improve appreciably until winter fattening starts again in earnest. An acre of mangolds will fatten four bullocks; an acre of grass, one. Meanwhile the present hotch-potch of dairying, rearing and a little fattening will continue in the district.

Sheep of the highest quality are bred, but not many Shropshires—only Cluns and Kerrys and crosses of these with the Down breeds. Prize-winning flocks of Cluns are to be found at the Ludlow end of the valley. Lambs (tegs), on beet tops and roots on the slope facing south, thrive unbelievably well with very little concentrated food, and no-one seems to know just why—"A thousand things are hidden still and not a hundred known." Perhaps the exceptionally good clover and ryegrass put in the racks have something to do with it. Strange as it may seem, crossbred lambs from the Cotswolds thrive best of all, although the ever popular Clun lambs rival them closely. It would astonish the breeders if they could see in March or April what their lambs had grown into. Unfortunately, pulpy kidney disease is becoming a menace to teg-fattening—especially while they are on swedes; it is hoped that inoculation against the disease will lessen the trouble.

Horses grow strong and big, and many prizes have been, and are being, won each year at the leading shows by a well-known enterprising breeder near the Wenlock end of the valley. Of course, such land is good for the horses' feet. No foot, no horse; but, in addition, horses in Corvedale develop good size, bone, and muscle.

Store stock markets nearby are Bridgnorth, Craven Arms, and Ludlow. These auctions are known over a great part of Britain.

The Corvedale pastures have to put up with much punishment, and their management cannot be said to be beyond criticism, for they are grazed too much in winter and are too bare by May Day to give the best results. In former times grassland was not worth studying—it was useless to grow grass intensively when the eating of it produced no profit. However, the pastures have improved to some extent recently, and in one or two places big bunches of satin-coated Hereford bullocks can be seen grazing luscious pastures with evident enjoyment.

THE HARPER ADAMS AGRICULTURAL COLLEGE

W. T. Price, B.Sc.
Principal

THE Harper Adams Agricultural College was founded under the trusts of the will of Thomas Harper Adams (1816-92), the last representative of an old Shropshire family. The family was associated in the eighteenth century with the famous Lord Anson, and the connection has been perpetuated in the coat of arms granted to the founder of the College and his brother and is now retained by the College; the wording of the crest is *Utile Dulci*.

The official opening ceremony was performed in September, 1901, by the Rt. Hon. R. W. Hanbury, M.P., then President of the Board of Agriculture, and since that date the College has continued without a break to give instruction in agriculture and the allied sciences.

The College was built in the Renaissance style, and the main block of buildings now covers over three acres. Situated about midway between Shrewsbury and Stafford, some 2½ miles to the west of Newport, it is in the heart of one of the finest agricultural districts of the country. The site is on the New Red Sandstone formation at an elevation of 250 feet above sea level, looking across the open but well-wooded country of the Shropshire Plain to the Wrekin, some eleven miles away, with the Welsh mountains in the distance.

The Ministry of Agriculture and Fisheries, the five counties of the West Midlands (Herefordshire, Shropshire, Staffordshire, Warwickshire and Worcestershire), and the City Councils of Birmingham and Coventry make annual grants towards the maintenance of the College, which is controlled by a Board of Governors, of which the present Chairman is T. C. Ward, Esq.

The National Institute of Poultry Husbandry, occupying some fifty acres, was established on the College farm in 1925 and was formally opened by H.M. King George VI (then H.R.H. the Duke of York) in November, 1926. The work of the Institute, which is part of the College, is devoted first to the development of specialized courses in poultry, waterfowl and rabbits, and second to the investigation, under practical conditions, of problems and new ideas in connection with poultry husbandry.

The present accommodation for students (mainly resident) is 150 ; this is being increased to 175 by the building of another hostel. The Ancellor House, the original home of the founder, has accommodation for twenty women students. The residential accommodation comprises study-bedrooms, with the usual common rooms, recreation rooms and library.

The College is exceptionally well equipped with science laboratories and workshops.

Some 20 acres of playing fields provide facilities for the chief outdoor sports, and there is also suitable provision for indoor amusements. The various social and athletic activities of the College are controlled by the Students' Union Club, and the *Cat-a-Mountain*, which is the official magazine of the Club, is published annually.

The association of former students, known as the Harper Adams Club, acts as a link between past and present students.

The College Farms The College farms cover an area of 340 acres, of which 50 acres are under poultry and 20 are devoted to gardens and orchards. The farm itself is partly heavy soil, boulder clay, and partly light land of the New Red Sandstone formation, and at present the cropping is almost equally divided between arable and grassland, of which an increasing proportion is long ley. In addition to providing for the winter requirements of the farm livestock, the arable land produces a wide variety of cash crops, including wheat, barley, linseed, potatoes, and sugar beet.

A dairy herd of 60 attested and abortion-free Ayrshire cows is maintained by rearing the young stock. In the autumn Hereford store cattle are bought for fattening on grass in the following summer. A small flock of 60 breeding ewes (Clun) is crossed with Shropshire rams to produce lambs for folding on sugar beet tops. The farm buildings have been modernized and re-equipped, and mechanization, both for the land and livestock, has been fully developed.

The objects kept in view in the management of the farms are to make them as instructive as possible by using them as demonstration farms for student classes, to give students an insight into the practical management of a "mixed" farm, and to carry out experiments on agricultural problems, including tests of crop varieties, under the auspices of the National Institute

Shropshire, cradled in the Severn

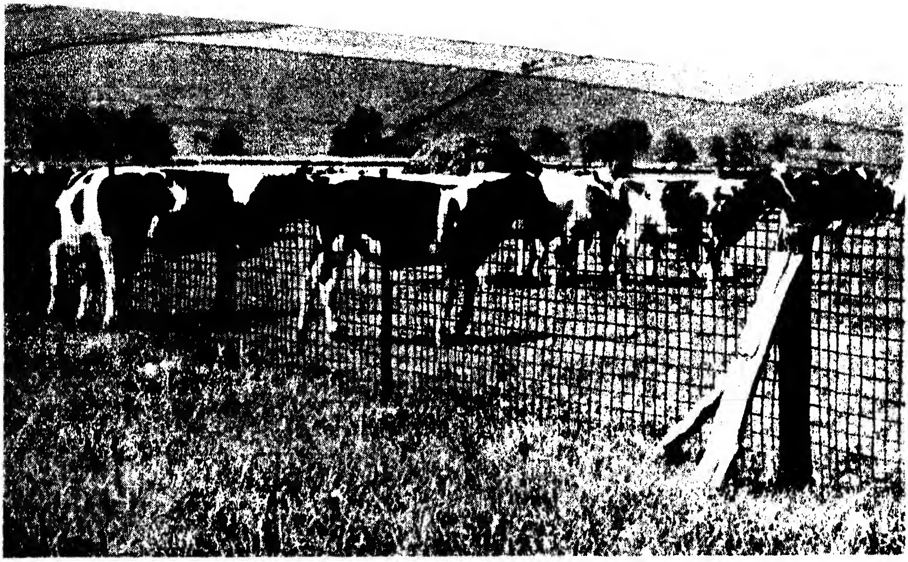


Photo: *Farmer's Weekly*

Attested, in-calf dairy heifers at Mixon Hay, Staffs. The stock are bought locally, raised by the Staffs. A.E.C. and sold either as bulling or in-calf heifers.

Photo: *Reece Winsto*

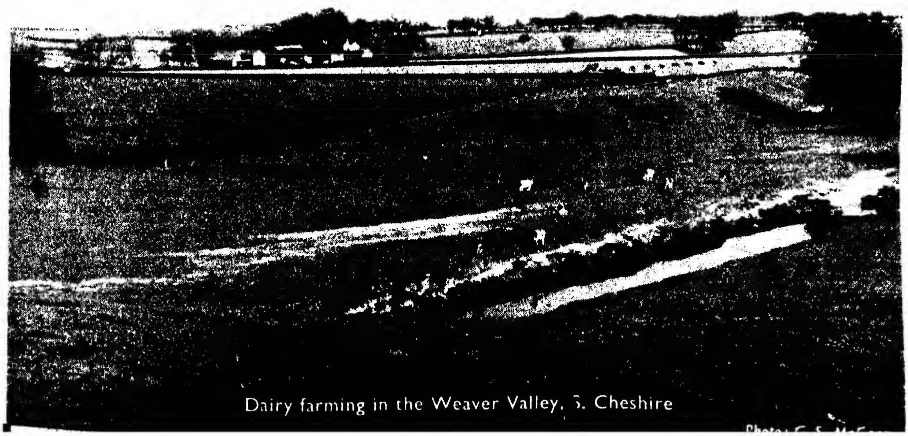
Ludlow

The Towne doth stand most part upon an Hill,
Built well and fayre, with streates both large and wide.

Thomas Churchy

Herefordshire. Cider apple bush Plantation

Worcestershire. Plum Plantation



Dairy farming in the Weaver Valley, S. Cheshire

HARPER ADAMS AGRICULTURAL COLLEGE

Front view of the College.

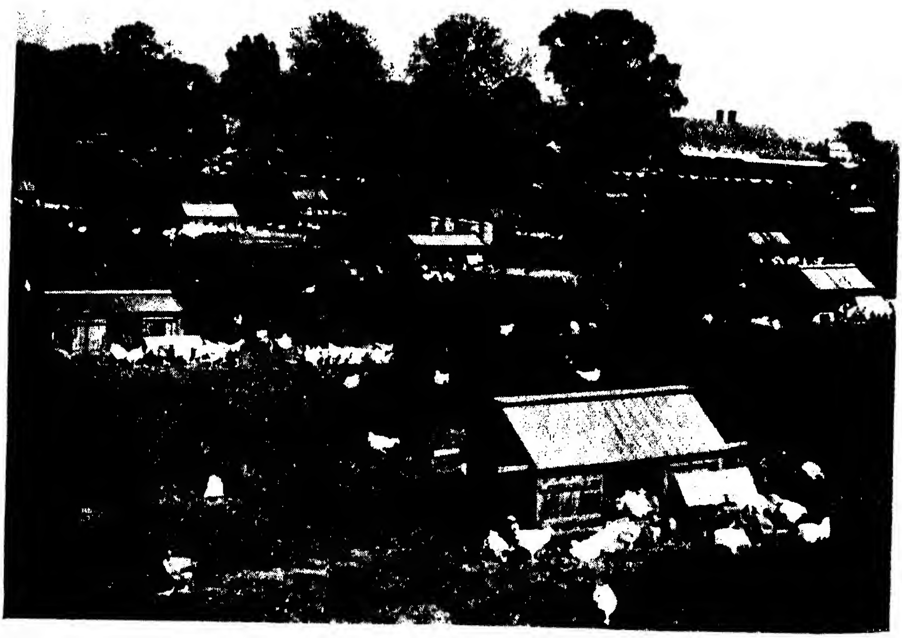
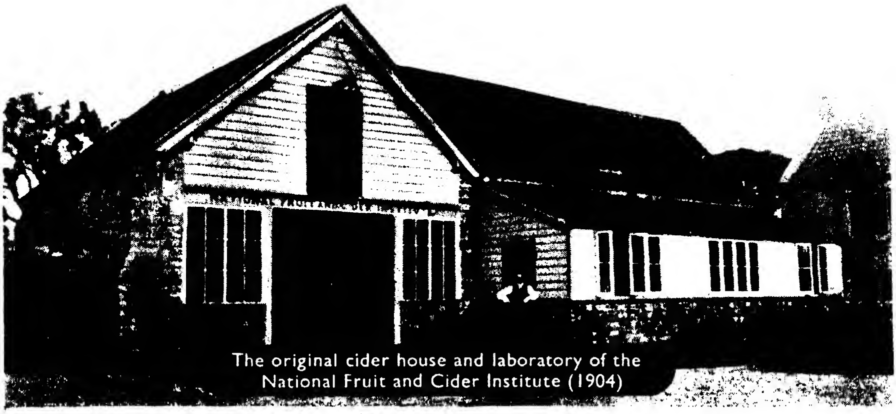
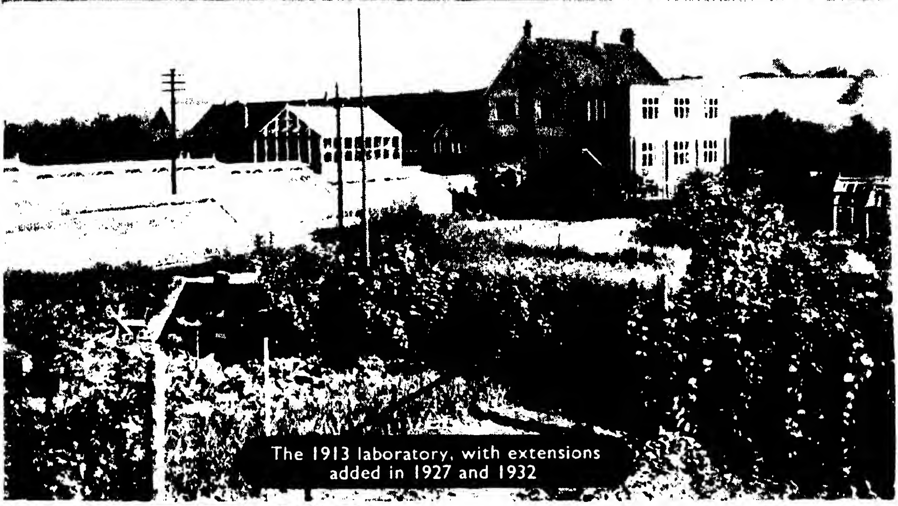


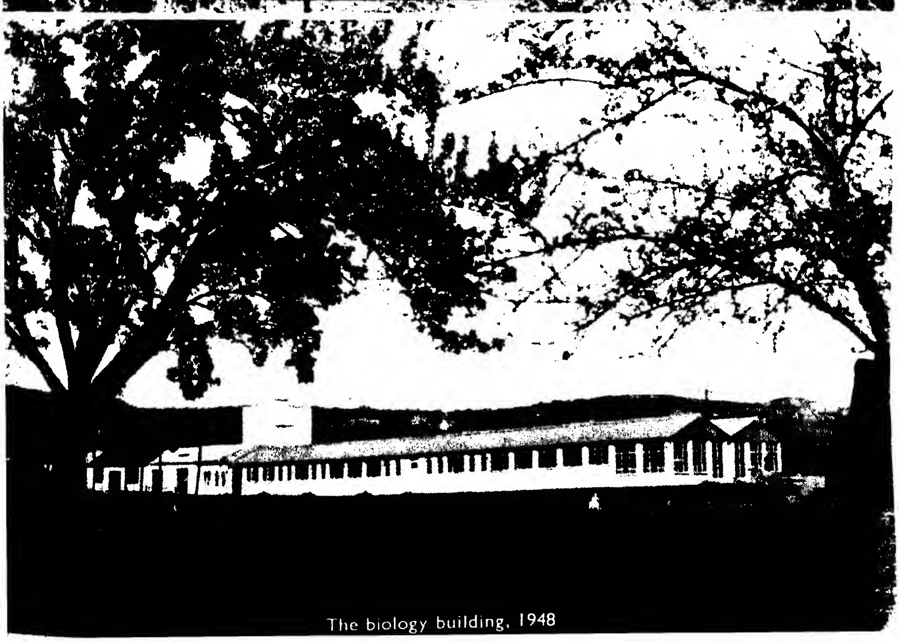
Photo Horace Hall

A section of the poultry rearing ground, showing young stock in Sussex Arks.

LONG ASHTON RESEARCH STATION


The original cider house and laboratory of the National Fruit and Cider Institute (1904)


The 1913 laboratory, with extensions added in 1927 and 1932


The biology building, 1948

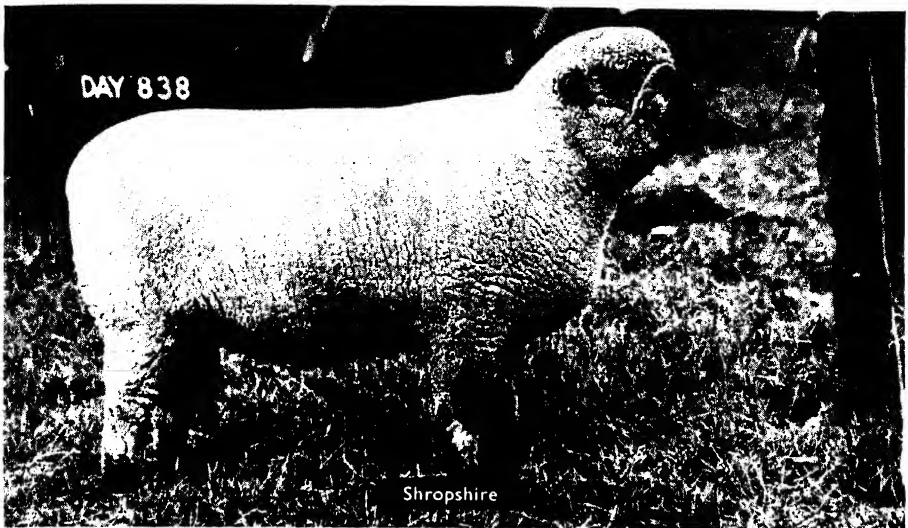
HOP GROWING

Continuous stringing in progress in a West Midland hop-yard.

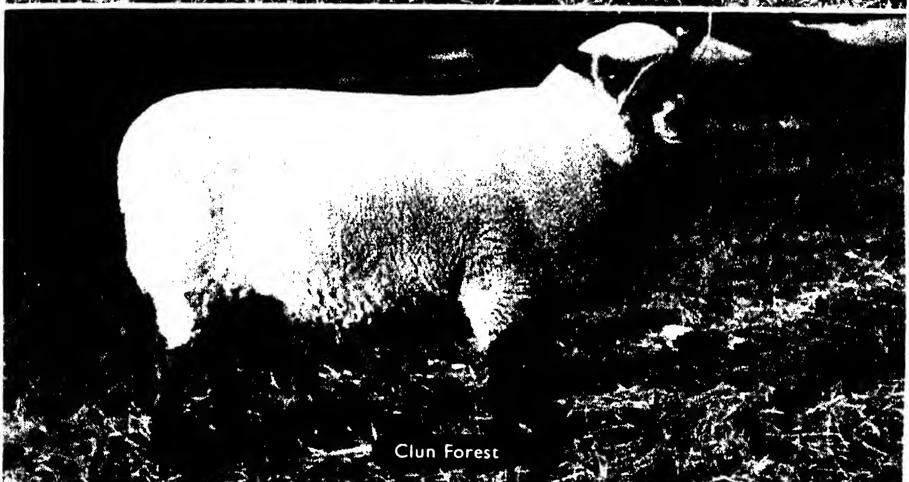
Harvest time. Note the crib and wickerwork basket used for measuring the hops.

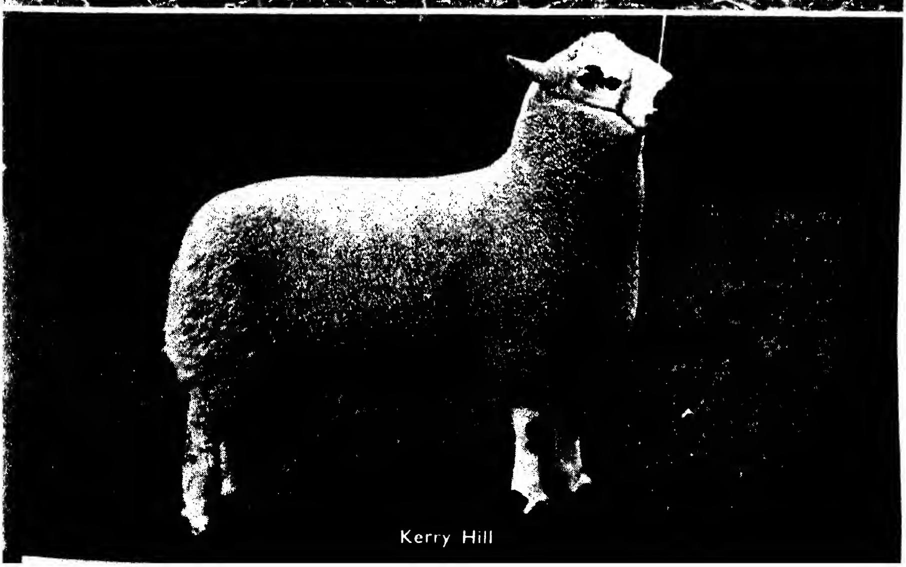
Photos: *G. A. Noll*

WEST MIDLAND SHEEP



Shropshire


Clun Forest


Kerry Hill

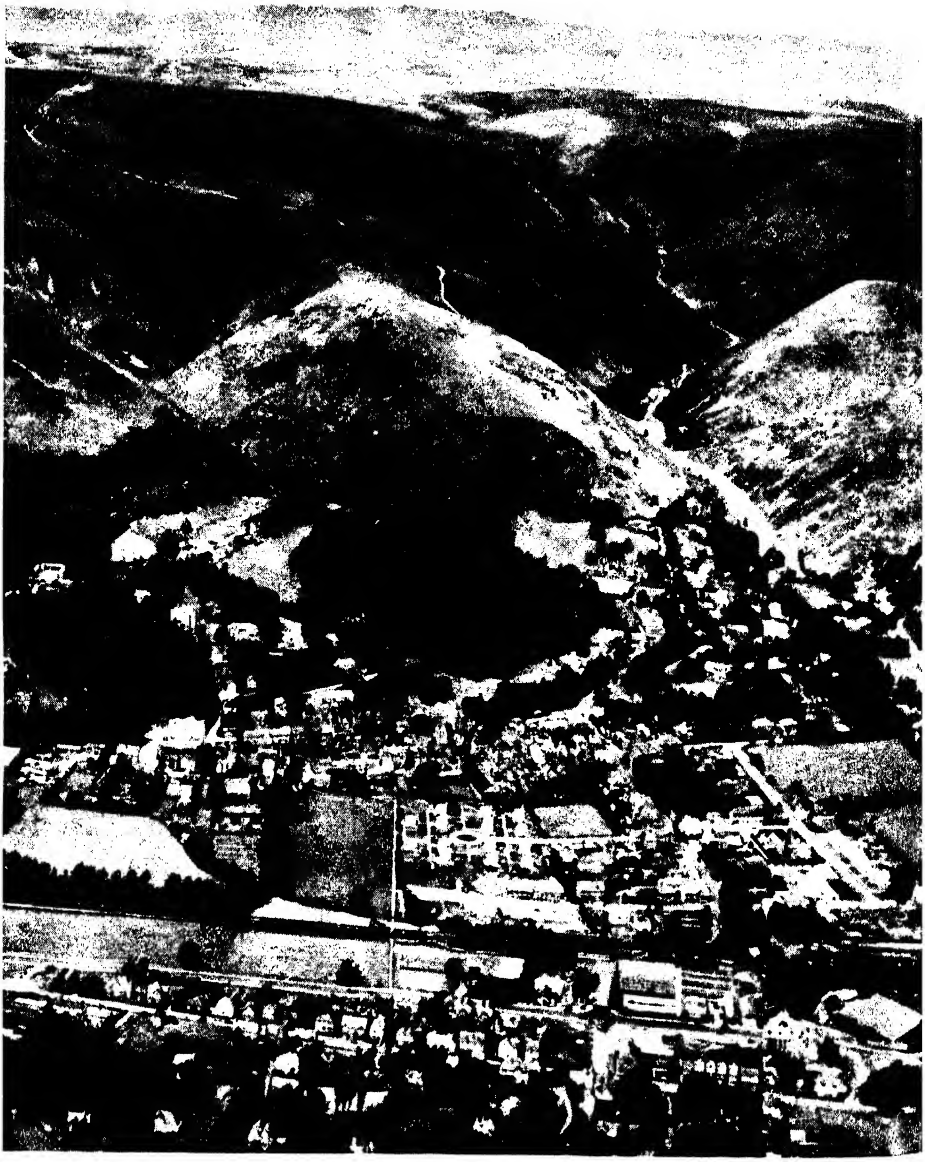


Photo: *Aerofilms*

Long Mynd, Shropshire

of Agricultural Botany, Cambridge. Parties of farmers frequently visit the farms, which it is essential should be run on commercial lines and show a reasonable profit, for they are not grant-aided like the College itself.

Pigs and Poultry In August, 1948, the Experimental Station was re-opened for the study of problems in pig husbandry. Although a certain amount of nutritional work will be carried out, the main emphasis will be on breeding problems. Several breeds are kept and an attempt is being made to assess the value of hybrid vigour ; also an interesting experiment is being conducted in "dual mating" by serving a sow at the same heat period with two boars of different breed, thus producing pure-bred and cross-bred pigs in the one litter.

A test is also being made to ascertain how far high-grade dried grass cubes can replace the normal protein in the fattening ration.

The Poultry Institute has its own instructional buildings and an extensive plant dealing with all aspects of poultry husbandry, including advanced instruction and experimental work. Representatives of the leading present-day breeds of poultry are kept for instructional purposes, while the large experimental flocks of the standard commercial breeds also are available for educational work.

The Institute is organized in three Departments—Poultry Husbandry, Waterfowl Production, and Rabbit Husbandry. The Poultry Department is subdivided into egg, table poultry and turkey production ; the Waterfowl Department into table egg, table duck, and goose production, while the Rabbit Department deals with pelt, wool, and flesh production. Most of the experiments are concerned with economic problems and are so designed that the results will be directly applicable to ordinary practice. With this in mind, relatively large units are used and experiments are often repeated to ensure reliable results.

Poultry on the farm is dealt with by fold units and slatted-floor houses both for laying stock and the rearing of pullets, since poultry are now considered as much a part of the farm economy as the other forms of livestock. Folded poultry, in conjunction with cattle and sheep controlled by electric fencing, are used to maintain fertility in the lighter arable land.

An investigation is at present being made into the relative costs of producing eggs on the three systems : laying batteries, intensive housing, and fold units.

Courses of Instruction The courses at the College, which are of two main types—agriculture and poultry—are designed for intending farmers and those who propose to take up salaried posts. The agricultural course is for male students only. The degree course preparing for the London external B.Sc. degree is temporarily suspended, in view of the large demand from ex-service men who wish to take a Diploma Course.

Agricultural (Farm Management) Course. This is a two-year course arranged to prepare for the College Diploma in Agriculture and for the National Diploma in Agriculture. It lays emphasis on farm engineering and machinery, and is of particular benefit to those who intend to manage land, in the capacity of owner, farmer, manager or bailiff ; the course also prepares students for salaried posts in the instructional, administrative, or commercial fields, either at home or abroad.

The conditions of entry are the School Leaving Certificate or equivalent qualification which can be met by the College entrance examination, and at least one year's practical farming experience to cover the farming calendar.

Whilst practical experience on the farm must always form the basis of an agricultural training, it can no longer be regarded as sufficient in itself. The design of the two-year agricultural course is to give the future farmer a broad outlook and a knowledge of fundamental scientific facts so as to take full advantage of the continual improvements in cropping, livestock, management, mechanization, economics and marketing, all welded together and applied under the heading of Farm Management.

At an agricultural institution the prospective farmer or technical adviser has the advantage of personal instruction by staff with special knowledge of all branches of scientific and practical agriculture. At the same time a student in a residential college comes into close contact with many different types of mind amongst his fellow students which cannot fail to have a broadening effect upon his own outlook.

POULTRY HUSBANDRY COURSE. This course of instruction of two years' duration prepares for the College Diploma and for the National Diploma in Poultry Husbandry, and is suitable either for the prospective poultry farmer or for the salaried posts. There is no degree in poultry husbandry, and the N.D.P.H. is the highest academic qualification that can be obtained in this field.

Qualifications for entry are the School Certificate or College entrance examination, and a period spent on an approved poultry farm.

LIVESTOCK HUSBANDRY. It is proposed to introduce a one-year post-graduate course in Livestock Husbandry which will be open to students who hold a degree in agriculture or the allied sciences. Emphasis will be given to genetics and the science of breeding for all classes of farm livestock, with special reference to poultry and pigs.

Appointments held by Past Students

Since the College was opened nearly fifty years ago a large number of students have passed through both the agricultural and poultry sections. Many former students have taken up practical farming, while others have found a wide range of salaried posts open to them. Former students are located all over the world in national and colonial appointments, administrative, instructional and commercial.

With the vital need for maximum world food production, prospective agricultural or poultry students can look forward with confidence to their future careers, provided they have equipped themselves with the necessary qualifications covered by the term "practice with science".

LONG ASHTON RESEARCH STATION

T. WALLACE, C.B.E., M.C.
Director

LONG ASHTON Research Station, which is administered by the University of Bristol, is one of the two national research institutes concerned primarily with problems of fruit-growing. Its work, although national in character, has always had a West Country bias and throughout its history the Station has given special attention to problems of growers in the West Midlands and South-West. Its origin and history are typical of West Country enterprise, and incidentally they serve to illustrate the

way in which many of our national research and educational institutions have arisen and flourished from the foresight and efforts of enthusiastic pioneers.

The Station had its origin in a scheme for experiments in cider-making, started in 1893, with the support of the Bath and West Agricultural Society, by Mr. R. Neville Grenville, on his estate at Butleigh Court, nr. Glastonbury, Somerset. Mr. Grenville had worked with the Society on its scheme for giving instruction in cheese-making on farms, and was so struck by the improvements which had resulted that he determined to apply similar methods to cider-making, which at that time was carried out on farms entirely by rule-of-thumb practices. The problem, however, differed from that of cheese-making, since nothing was known of the principles of cider-making, and hence the subject could not be taught. The situation did not daunt Mr. Grenville. He recognized that the first step should be to carry out research on cider-making processes. An appeal to the Board of Agriculture for funds to enable him to begin work met with refusal on the grounds that the Board did not finance research but only gave grants for education. In spite of this refusal, Mr. Grenville began his experiments on his farm at Butleigh, with the support of the Bath and West Society and the help of his old colleague of the cheese school, Mr. F. J. Lloyd, a chemist by profession After a while the support of the Board of Agriculture was gained, when Mr. Grenville was able to demonstrate to one of the Board's inspectors, Mr. R Brooke Hunt, by means of a visitor's book, that the experiments were essentially educational in character.

The National Fruit and Cider Institute

The work continued in the original quarters for ten years, by which time its great value had become recognized not only by the Board of Agriculture but also by a wide circle of farm cider-makers and the County Councils of the cider-making counties Thus it came about that in 1903 a scheme was evolved to transfer the experiments to a centre where the work could be developed under more favourable conditions The scheme, in which Mr Brooke Hunt played a leading part, was sponsored by the Board of Agriculture, the Bath and West Society, and the County Councils of Devon, Gloucester, Hereford, Monmouth and Worcester, all of which undertook to provide annual grants to establish a small research centre. The final outcome of these efforts was the formation of the National Fruit and Cider Institute, with a membership scheme for farmers and others interested in cider-orcharding and cider-making. In 1904 the Institute acquired premises for its work at Long Ashton on a farm belonging to the Ashton Court Estate, consisting of a farm cottage for use as an office and a small farm building which was converted into a small factory. To these was added a small wooden lean-to structure to serve as a laboratory. Along with these buildings, eight acres of adjoining land were obtained for experiments on cider-orcharding, the whole of the property being held on lease.

A young Cambridge graduate, B. T. P. Barker, who later became the first Director of the Long Ashton Research Station, was appointed to initiate and carry out the scientific experiments, and it is of interest to relate that Professor Barker (as he now is), though retired from the post of Director, is still hard at work in his laboratory at the Station, applying the latest methods of science, with all his old enthusiasm, to some of the more baffling problems which he first encountered during his earliest years at Long Ashton.

The optimism and faith of the founders of the National Fruit and Cider Institute can be gauged from the fact that the total annual income of the

Institute in those early years was about £1,100. The Institute continued to function as an independent body until 1912, when it became associated with the University of Bristol as one of the agricultural research institutes established by the Ministry of Agriculture and the Development Commissioners with grants made available by the Development Act of 1909. In its new role the Institute was asked to undertake research on problems of "Fruit Culture and the Practical Control of Diseases and Pests of Fruit Trees," in addition to its original subject of cider.

To enable the Station to carry out its new programme the University purchased the farm, comprising 257 acres, on which the original premises were situated, built a new range of laboratories and erected a cider factory to permit large-scale experiments being carried out. Developments under the new scheme, however, were arrested by the 1914-18 war, and it was not until 1919 that a substantial expansion of activities began. In this latter year new appointments were made to the scientific staff and new field experiments were planned on both commercial and cider fruits.

Concurrently with the acquisition of its new status in research, the Station became the Agricultural Advisory Centre for the Bristol Province and continued to serve the farming community in this way until 1946, when this work was transferred to the National Agricultural Advisory Service.

Since 1919 the work of the Station has shown steady expansion which has necessitated greatly increased staff and accommodation. In 1919 the total scientific staff numbered 7, whilst in 1939 there were 22 qualified scientists; by 1947 this number had increased to 31, and it had been found necessary also to appoint a considerable number of technical assistants. To meet accommodation requirements two further additions were made to the laboratories in 1927 and 1932, and a new biology building was erected in 1947. The Station also possesses various special-purpose buildings, including experimental greenhouses and workshops. The field experiments, which occupied about 8 acres in 1919, now occupy an area of approximately 120 acres and, in addition, the Station has established many experimental cider fruit orchards on private farms, particularly in the cider-making counties of the West.

One further subject of interest was added to the Station programme in 1922—that of willow culture and the utilization of willows; these industries are of importance, especially in central Somerset around the historic Isle of Athelney and in various small areas scattered over England and Wales, for all of which Long Ashton serves both as a research and advisory centre.

No account of the early activities of Long Ashton would be complete without reference to its Annual Cider Tasting Day. This function, whose main object was to keep farmers and others interested in cider-orcharding and cider-making in close touch with the results of research, was held annually up to 1939 at the Institute on the first Thursday in May. It attracted farmers from all parts of the West Country and did much to improve and popularize cider, even to the extent of raising it from a local to a national drink. Since the recent war it has been necessary to restrict the day to a cider sampling function attended only by experts.

The 1939-45 war naturally disorganized to some extent the main lines of fruit research, and the Station undertook many special war-time problems appropriate to the special scientific qualifications of the staff and the equipment available. Since 1945, however, most of the special war-time investigations have been concluded and a comprehensive programme of fruit research has been planned and put into operation.

Current Research Work The main subjects of research with which the Station is concerned at the present time may be grouped under the headings of Pomology, which embraces the general subject of Fruit Culture; the Control of Insect Pests and Fungoid and other Diseases; the Manufacture of Cider and other Fruit Juices, the Domestic Preservation of Fruit and Vegetables; Plant Nutrition, including both agricultural and horticultural crops; and Willow-Growing and the Utilization of Basket Willows.

During past years the Institute has also been concerned with Soil Surveys and Diseases of Vegetables and Hops—but these subjects have now been transferred to other centres.

Pomology The first systematic researches in pomology in this country were initiated in 1894 at the Woburn Experimental Station by the Duke of Bedford and Mr. Spencer Pickering, and were continued until 1922. The results obtained were not widely accepted by practical fruit growers, but they gave rise to much controversy both among growers and scientists and showed the complexities of the problems involved and the need for comprehensive investigations. Many of the problems examined at Woburn were later re-examined at Long Ashton and often formed the starting points of studies which have since yielded valuable practical results.

The main problems in pomology concern factors which govern the growth and fruitfulness of trees and the quality of the fruits produced. At Long Ashton these problems have been approached with two objects in view: to solve the fundamental scientific problems involved, and the special practical problems of the West Country grower.

The scientific problems concern the intrinsic qualities of the fruit plants themselves and the effects of the orchard conditions (i.e., the environment) on the plants. As regards the plants themselves, each different class of fruit, and even each variety, may present its own particular problems. For practical purposes it is thus dangerous to generalize from limited investigations on the behaviour of fruit in general or on any class of fruit. Again, these intrinsic qualities may be modified greatly by natural orchard conditions and management practices, such as climate, soils, cultivations, manuring, pruning, and the control of insect pests and diseases. The effects of these different factors and their interactions must all be determined if vegetative growth and cropping are to be controlled.

In fruit trees the rootstocks on which the varieties are budded or grafted produce important effects on growth and fruitfulness, and rootstocks may be raised either vegetatively, by means of layers and stools, or from seed. The latter method has always been preferred for West Country orchard trees, and hence Long Ashton has made a special study of seedling root-stocks.

Tree forms (bushes, standards, dwarf pyramids, cordons, etc.) and pruning systems are perpetual subjects of controversy among growers, and Long Ashton has continued to devote attention to them. In the early days, the late Mr. A. H. Lees examined the "Lorette" method of spur pruning and the intensive methods of growing upright cordons and dwarf pyramids. Later, Dr. T. Swarbrick and Mr. C. R. Thompson compared the merits of "open centre" and "modified leader" tree forms for apples and pears, and Mr. Thompson subsequently developed his now well-known method of renewal pruning. More recently the ancient method of growing cider fruit on standard trees in grass orchards grazed by stock has been challenged by trials of bush trees, which have been shown to produce heavy yields as early as 8 to 10 years after planting.

Much attention has also been given to problems of fruit quality, both for commercial purposes and for cider-making, and, as a result of this work, quality can be controlled to a considerable measure.

The latest method of attacking these problems of regulating growth and fruitfulness has been by the use of growth-promoting substances or "hormones". In these studies an attempt will be made to discover the particular substances responsible for the various stages in the production of fruits and for determining keeping quality. Can we, in fact, by such means, initiate fruit buds; cause fruit to form from blossoms without pollination, and prevent the dropping of fruitlets in June and later when fully grown ? Then, after picking, can we prolong or accelerate the storage life of the fruits ? Good progress has been made with some of these problems, and already a natural hormone has been isolated from the seeds of apple fruitlets which will swell tomato fruitlets and appears to prevent the "June drop" of apples.

Fruit Nutrition The investigations on fruit nutrition have conferred great benefits on the fruit-growing industry. They have provided a basis for manuring the various classes of fruit, suggested alternative methods of cultivation to the one-time universal arable method, and have enabled many soils previously considered as unsuitable for fruit-growing to be utilized to great advantage for this purpose. The problems were attacked from the simplest beginnings, since it was recognized that to get down to fundamental points the complications occurring in orchards had to be avoided. Thus in the initial stages the various kinds of fruits were all grown in sand in large clay pots, where conditions of feeding, watering, etc., could be readily controlled, and the plants were fed on different mineral diets. The main effects of deficiencies and excesses of nutrients were determined and the knowledge gained was tested on special experimental plots at the Station and in growers' orchards and plantations. In this way the main problems of different kinds of soils and the effects of different manures on the various fruits were ascertained, and methods for the correction of unfavourable conditions devised.

The most important points which emerged were that potassium deficiency was the cause of the condition known as Leaf Scorch and that potash was of paramount importance in the nutrition of all classes of fruits.

Another point of importance was the recognition of the relation of fruit colour and quality to nitrogen supply—a finding which enabled growers to regulate colour between red and green by means of regulating the nitrogen supply to the trees. The investigations also brought into prominence the relationships of grass and arable systems to nitrogen nutrition. Later it was shown that, besides the importance of nitrogen and potassium problems in orchards, deficiencies of magnesium, iron and manganese were of common occurrence, and means of correcting these were devised and are now in common use by growers.

Considerable attention was also given to soil surveys, in which soil conditions were related to the growth of fruit plants, the most important areas surveyed being the Old Red Sandstone areas of Herefordshire and Worcestershire, the Vale of Evesham, the Cheltenham market-garden area, and the cider-growing district around Martock, Somerset.

Fruit Quality Brief reference must also be made to the long series of experiments carried out to determine the effects of orchard factors on the eating and keeping qualities of fruits, mainly of apples. The problems are again complicated owing to the various inter-

actions of the factors involved, but the investigations clearly showed the main effects due to the factors of varieties, rootstocks, cultivation, manuring, pruning, bark ringing, position of fruits on the tree, time of picking, and size grades within a crop. The knowledge is basic to any attempt to regulate quality to suit the eye and taste of the customer, and to the adoption of orderly methods of storage and marketing without risk of losses from storage rots and physiological disorders.

Fruit Breeding Breeding new varieties of fruits is a long-term business, and because of this and of the large areas of land required to grow the seedlings, it is very expensive. Long Ashton experiments, initiated over twenty years ago, have only recently begun to give new varieties to the industry. Several varieties of apples have reached the stage of the Wisley trials; two pears (Bristol Cross and Cheltenham Cross) and one plum (Severn Cross) are finding favour with growers; and three varieties of black currant (Mendip Cross, Cotswold Cross and Malvern Cross) are being widely planted. In the most recent experiments attention is being given to the filling of gaps in present supplies, especially the extension of fruiting seasons by the addition of early and late varieties, and to producing cider varieties with special qualities.

It will be noted from the varieties named above that Long Ashton seedlings are all given West Country names.

Control of Insect Pests and Fungoid and Other Diseases The control of pests and diseases in the orchard is perhaps the most expensive item in the annual budget of fruit production, and there is no escape from this expenditure if fruit of good market quality is to be produced. For this reason the subject has always been prominent in the Long Ashton programme of research.

In 1920, methods of control were both primitive and unsatisfactory. Lime-sulphur was little used and indeed was suspect in its effects, there were no winter washes, and many present-day varieties, such as Cox's Orange Pippin among apples and Williams among pears, were not regarded as commercial sorts, mainly due to the effects of Scab. Older plum growers will also remember "aphis years" in the Vale of Evesham in the early 'twenties, before tar oil washes were introduced, when trees and crops were devastated.

The necessary research for pest and disease control involves studies of the pest and disease organisms, chemical materials for sprays and dusts, and machinery for applying them. Long Ashton has included all these items in its programme.

Perhaps the starting point of the modern improvements in methods of control was the introduction of the first tar oil winter wash from Holland in 1921 by S. P. Wiltshire, then mycologist at Long Ashton. The wash was tested during the following year by A. H. Lees and was found to kill the eggs of a number of important fruit pests which overwinter on the bark of various tree fruits and bushes. This discovery revolutionized plum-growing and solved many major problems of pest control of apples, pears, currants, and gooseberries. The wash was quickly improved at Long Ashton by F. Tutin, who also determined the active "egg-killing" constituents of the wash. Later, a team of workers led by H. Martin, H. G. H. Kearns and R. W. Marsh settled down to the formulation of complete seasonal spray programmes for the various fruits, by developing "combined" and "multiple" sprays calculated to control the majority of

the major pests and diseases when applied in succession during the winter and spring months

Problems of control, however, are not static: new pests and diseases come into prominence, necessitating continuous research and changes of programme.

The present team at Long Ashton comprises entomologists, mycologists and chemists who are competent to attack problems of pests and disease organisms, chemical materials used in sprays, and technical problems of spraying machines and equipment. The Station has a small engineering shop, which, incidentally, was in continuous use during the war for improving and servicing spraying outfits supplied by the Ministry of Agriculture for the use of County War Agricultural Executive Committees.

Virus diseases have not been special subjects of study at Long Ashton, although important contributions have been made in this field also. For example, A. H. Lees first showed "Reversion" of black currants to be due to virus disease and to prevent its spread he developed the system of "roguing", which is still in use. Recently attention has been given to possible virus diseases of tree fruits, and already three of importance, all transmissible by grafting, have been recognized—"Mosaic" and "False Sting" of apples and "Stony Pit" of pears—whilst curious conditions of the apple variety Lord Lambourne, known as "Rubbery Wood," "Chat Fruit" and "Flat Limb," and a condition similar to "Rubbery Wood" in some plum varieties, which may all be due to viruses, are being studied. The importance of these investigations will be apparent to growers who have suffered the devastations of virus diseases in soft fruits.

Cider and Fruit Products Cider is, of course, the "old love" of the Station, and to the local population the Research Station is, and may always remain, "The Cider Institute". Cider fruit-growing and cider-making have throughout been major subjects of research. The problems of cider-making concern the raw materials used, the expressed juice, fermentation, the storage and maturing of the product, and organisms which may cause spoilage.

It is difficult in a short article to provide any adequate picture of cider researches at the Station, but the significance of the work may be judged from the facts that during the life of the Institute cider has developed from a local farmhouse drink to become a national beverage, and cider-making from a farmhouse occupation to an industry. Moreover, many of the larger cider-makers have developed from the farm stage after training at Long Ashton, and today, as always, the Station continues in the closest touch with, and enjoys the complete confidence of, the industry. These links, at the present time, are kept strong by means of Institute Committees, on which sit representatives of cider-growers and cider-makers, to deal with the problems of cider fruit supplies and of cider-making.

In cider-orcharding the main problems relate to the orchard and cider-making qualities of varieties and to devising management practices appropriate to the value of the crops.

The problems arising from cider manufacture are very varied and require, in particular, intensive studies in biochemistry and microbiology. Large-scale problems are dealt with in the Institute factory, which is now rather old-fashioned, but it is hoped soon to have a model building to carry out pilot-scale experiments in both cider-making and the manufacture of fruit juices.

Fruit products investigations were a natural extension of the cider experiments. The general problem presented was: Could a range of

products be made from the apple and other fruits, ranging from non-alcoholic beverages to products of high alcohol content such as apple brandy and liqueurs? The main object of these extensions in the work was to develop methods of utilizing fruit surpluses and low grades of produce which result from grading and marketing schemes.

Preliminary work showed that a wide range of attractive products could be made from the different fruits and, later, attention was focused on two outstanding products—pure apple juice and black-currant syrup. The work was interrupted in 1939 by the war, when apple juice manufacture was restricted, but it will be recalled that the blackcurrant syrup was used throughout the war period as an important source of vitamin C for children. Other developments which arose from this work were the cold sulphur dioxide process for preserving commercial fruit pulp and its domestic counterpart, the well-known Campden preserving tablets used in fruit bottling operations.

Fruit and Vegetable Preservation Methods This subject is scientifically closely related to the subjects of cider and fruit products. The work arose out of official schemes for domestic preservation of garden produce during the 1914-18 war. It aims at providing methods of preservation which can be used either in the home or in rural centres run by organizations such as the National Federation of Women's Institutes. The Station undertakes the basic research for the methods and also provides annual summer courses for instructresses employed by County Councils and other bodies engaged in teaching domestic science subjects. Many readers will be familiar with such publications as the Ministry's bulletin *Domestic Preservation of Fruit and Vegetables*, and the Penguin book *Preserves for all Occasions*, which are based on the Long Ashton work.

Plant Nutrition This section deals with special aspects of the nutrition of the whole range of agricultural crops. It was formed during the war by the Agricultural Research Council to give special attention to problems of crop failures and the particular problems of trace elements, such as boron, manganese, and iron. It was important at that time to develop quick methods of diagnosis that could be used by advisory officers and farmers. To provide for this, rapid visual methods, supplemented by spraying and injection techniques and quick chemical tissue tests, were developed and put into use. The methods were described and illustrated in a special colour atlas* published by H.M. Stationery Office, on behalf of the Agricultural Research Council. They were also used to make rapid surveys of crop nutrition problems in special areas of the country where new and difficult problems had arisen from the war-time ploughing-out programme. Since the war the investigations have been extended to examine special problems, such as the reasons for crop failures on acid soils, the causes of iron deficiency in crops, and the significance of molybdenum in crop production. The investigations may be expected to make important contributions to the solution of important and obscure problems of crop production and maybe also of animal health.

---

* T. Wallace. *Diagnosis of Mineral Deficiencies in Plants by Visual Symptoms—A Colour Atlas and Guide.* 1st edition 1944. 2nd edition in the press.

Willow Culture and the Utilization of Basket Willows The cultivation of basket willows is carried out in small areas throughout England and Wales, notably in Somerset and the Trent Valley. The industry is rather unstable, due to its inherent nature and to intensive competition from abroad, but is important in the agricultural economy of certain areas and has proved of importance to the national effort in both world wars. Long Ashton has endeavoured to help the industry both as a research centre and in an advisory capacity.

The main research problems concern the improvement of varieties and methods of culture, and the devising of improved methods for peeling and preparing rods for market. The control of diseases and pests presents very difficult and important problems in attempting to produce rods of high quality and greatly improved methods for controlling these have been evolved. Considerable help has also been given to growers of cricket bat willows. The Station has its own willow beds, which contain a large number of seedling varieties bred during the course of the work.

Conclusion The above account of the work of the Station is of necessity superficial and deals inadequately with many important research activities. It is hoped, however, that it will provide a general picture of the Station's work and enable readers to see the part which Long Ashton is endeavouring to play for the benefit of agriculture, both locally and nationally. Those specially interested in the subjects outlined in this review may keep in touch with the work of the Station through its Annual Report, which contains both scientific and practical reports of researches in progress and of results of completed investigations.

SHEEP ON THE ENGLISH-WELSH BORDER

J. F. Robinson, B.Sc.

THE historic town of Shrewsbury is a popular choice for this year's Royal Show, not least because it is one of the oldest livestock centres in the kingdom. In addition to its Hereford cattle, the Welsh Border country is the home of four breeds of sheep—Ryeland, Shropshire, Clun Forest, and Kerry Hill.

Historical The special characters of these local breeds of sheep have been chronicled by many early writers. Modern improvements date from about the time of Bakewell, chiefly through the introduction of New Leicester and Southdown blood. The Ryeland, originating in south Herefordshire, is one of the oldest breeds of which there are records. Old references claim for it two distinctions—the extra fine quality of its wool, and a natural propensity for thriving on scanty fare. These points remain as true as ever, though one's chief impression today would surely be the animals' compact, symmetrical conformation.

Further north the Shropshire, which is characteristically "Down," and (indirectly) the Clun Forest, have evolved from crosses of the Southdown on the old local races, especially the Morfe Common and Long Mynd Mountain sheep. The latter are now extinct, but a few sheep of a similar type—the "Radnors"—are said to remain. Youatt, writing about 1830, records that the Morfe Common resembled the old Ryeland. It may now seem rather odd that it should be noted "this ancient breed are black-faced, or brown or spotted-faced, horned sheep—and of a slow-maturing

type." Present-day breeders must read these old accounts not only with amusement but also with the pride of accomplishment.

The Kerry Hill was originally an improved mountain type, but its subsequent improvement has been on similar lines to that of the Clun Forest. There are historical references to an exchange of rams between the two breeds, but since about 1850 improvement has chiefly been by selective breeding, especially for the distinctive face colours and hardy breeding qualities.

Distribution : The Ryeland The Ryeland is a lowland breed kept chiefly for ram-breeding and supplying stock sheep for overseas. Most of the pedigree flocks are in Herefordshire and the neighbouring counties. Others are scattered in different parts of the country, mainly in the south.

Like fruit, for which this county is also renowned, Ryelands appear to do best in a dry, sunny climate. Being a thrifty type of sheep, they will do remarkably well on poor land. At one time a number of flocks were established around the Tonbridge area in Kent, where the Ryeland rams, like the Southdowns, were sold for crossing with the Romney Marsh ewes. The market now requires heavier sheep, though the small breeds, such as the Ryeland or Southdown, are still a useful choice for crossing to get high-quality summer fat lambs, or with "first-crop" ewes to avoid difficulties at lambing.

Unlike the Down breeds, the Ryeland has developed chiefly on grassland. In Herefordshire, for example, it is more typical of the mixed stock and fruit farms than of the strictly arable farms found in the Wye Valley. In many respects, the Ryeland is an answer to those who think that conformation of the Down type cannot be developed and preserved except under systems of continuous close-folding on arable crops.

Like Hereford cattle, Ryeland sheep have proved their adaptability under different conditions both at home and abroad. It is questionable, therefore, whether the Old Red Sandstone on which the breed originated is of importance for keeping them true to type, though when bred in other areas they are said to grow slightly coarser, especially in the wool.

The Shropshire This is one of the most general-purpose of the Down breeds, and it has been bred to suit mixed arable farming in Shropshire and the adjoining counties. The Shropshire is bigger than the Ryeland, and has long been a popular choice for fat lambs, or for lambs for "tegging". A substantial rootbreak is still reckoned one of the pillars of good husbandry on the English-Welsh Border, especially on light soils. The Shropshire and other Down crosses, from Clun and Kerry ewes, make good weights after cleaning up the sugar beet tops and finishing on the roots.

Although the Shropshire has been bred on "Down" lines, it has retained many hardy qualities of the original stocks. The ewes, for instance, may run almost entirely on grassland and consistently rear a lamb crop of 150 per cent or more. Their high fertility in comparison with other Down breeds may be due also to a more steady rainfall, and the fact that the ewes receive plenty of free range on a more productive type of pasture.

Though triplets are an embarrassment, twins are favoured, since the Shropshire ewes are good nurses. A fair proportion of the rams are brought out as shearlings, which obviates the forcing of twins to enable them to catch up with the singles.

The Shropshires have been prominent in the export trade, since they have proved adaptable to a variety of climates. In North America breeders have their own flock book, and their sheep outnumber those in Britain. Other countries now appear to have succeeded in evolving types to suit their own conditions, though home breeders hope that relaxations of the currency and other restrictions will stimulate the demand from overseas.

The Clun Forest and Kerry Hill The Cluns and Kerrys belong mainly to the rearing districts of the West. The former derives its name from an area in the semi-uplands of south-west Shropshire, and the latter from its native hills in Montgomeryshire. The relative proportions of registered flocks occurring in different counties give an idea of the distribution of the two breeds.

County	Cluns	Kerrys
	Percentage of Registered Flocks	Percentage of Registered Flocks
Shropshire	37	16
Herefordshire	29	13
Radnor	6	9
Montgomery	4	31
Worcestershire	4	1
Other counties	20	30

The Ryelands and Shropshires are naturally restricted to the lowlands, where they run more or less as a sideline to cattle-fattening or fairly intensive arable farming. In the uplands, where the soils are "thinner" and winter keep less plentiful, the concentration is on sheep-breeding, often with cattle-rearing or "suckling" as a subsidiary. The following Table gives a broad indication of the type of farming.

Stock per 100 acres of Total Area (June, 1944)

County	Total Sheep	Total Cattle
Shropshire	40	30
Herefordshire	65	23
Radnor	119	12
Montgomery	112	18

This, however, is only a part of the story. The ultimate trend, whether of sheep or cattle or men, is by intermittent stages from the hills to the valleys. A large surplus of breeding ewes and store lambs from many different types of land is the end product of cleverly integrated systems of stock management.

The Clun Forest is the youngest of the Border breeds of sheep and has evolved from a cross of Shropshire rams on hill ewes of the old Radnor type. The original crosses were required for fattening, and it is probable that the desirable breeding qualities of the females were first discovered accidentally. The offspring of Down rams on hill ewes, though first-rate feeders, often prove to be disappointing breeders. The Cluns are rather exceptional in retaining many of the useful qualities of the hill parent stock.

In regard to the management of early Clun flocks, it is noteworthy that for a long period the fattest lambs, which were mostly singles, were sold during the summer, and the leaner ones kept on as stores—the ewe lambs for breeding. In this way it is probable that a greater proportion of the twin ewe lambs would be retained for stock, and this may have favoured the development of the prolificacy which is claimed to be one of the most valuable characters of the breed.

The Kerry Hills have sprung from a more typical hill environment. In some districts the Kerry may compete with the Welsh, or they may be crossed with the Welsh to give a hardy local type of ewe known as the "Peckle Kerry". The best Kerrys, like the Cluns, are bred on the lower slopes, especially on the land overlying limestone north and north-east of Craven Arms.

There are considerable differences in the size and "bone" of Kerry and Clun sheep, according to the land where they are bred. These are interesting adaptations to environment, which are also helpful to intending purchasers of draft ewes, who thus have scope for choosing sheep suitable for their "ground". More remarkable, perhaps, is the way the sheep change type after a few generations of breeding on rich lowland pastures. This serves to emphasize the complementary role of heredity and environment, which is by no means peculiar to sheep-breeding on the English-Welsh Border.

Breeding : The Ryeland The Ryeland is often referred to as the "white faced" Southdown, indicating the similarity of ideals. A fairly small, well-proportioned animal, is regarded as typical of the breed, and breeders have refrained from selecting for excessive size. In addition to a "good sheep", breeders insist on the white face and legs and a medium short ear of characteristic shape and texture. Although in the nature of fancy points, it is interesting to note they form a practical guarantee of pure breeding, since they preclude out-crossing with other breeds. In some districts a white face is not favoured in rams to be used for crossing. In the Ryeland, however, as in the Dorset Horn, it is related to complete freedom from coloured fibres in the wool.

The Flock Book, which is closed, was started in 1903. The sheep are registered individually, and great importance is attached to strain in matching up the ewes and rams. Lambing takes place in January and February, when the ewes may be brought to shelter and receive some extra feeding. The ewes and lambs return to the pastures a few days after lambing. The ewes are docile and excellent milkers, and lamb crops of 125 to 130 per cent are usual. The clip averages about 6½ – 7 lb. of washed wool. Ryeland lambs grade 40–50 lb. dead weight in the summer and about 70 lb. as tegs.

The Shropshire Despite common aims—the most economical combination of mutton and wool—two types of Shropshires have developed. One is the thick-set sheep of medium size, with a close cover of wool, and the other a less compactly built sheep with a slightly slacker fleece and less cover. The former type was developed at the beginning of the century to meet a keen export trade, which favoured the shorter leg and woolly head. The latter type has always been favoured in the home market, in which general hardiness in commercial sheep tends to be associated with the extra size and a cleaner face and legs.

It seems difficult to select for a heavier fleece without at the same time increasing cover on the body extremities. The ideal appears to be to compromise and avoid the wool meeting too much below the eyes, since wool there interferes with sight, especially in snowy or wet weather.

The relationship of "cover" to hardiness and milking qualities in the ewes is even more obscure, since shepherds report that there are good and bad nurses among both the woolly and the bare-headed ewes. In this connection there is the complicating factor of size. Since the small, compact sheep tend to be fatter than the larger ones, they are unlikely to have the same disposition for nursing their lambs.

With these reservations, the type is well fixed, and, as in the Ryeland, the breed stamp is indicated by different head points. The head and legs are of a dark, sooty black colour. The head is of medium length and the ears fairly short and fine in texture.

The Shropshire Flock Book was started in 1882, and the Society's sales are held at Shrewsbury. As in the case of the Ryelands, the majority of rams are disposed of as shearlings. It is interesting to speculate whether the preference for shearlings rather than ram lambs has influenced selection for the natural thriftiness and longevity in the ewes, which characterize these breeds.

Shropshire flocks are now run mainly on grassland, and are profitable "scavengers" on mixed arable farms. Their fleeces average 8-9 lb. of washed wool, and those of yearling rams about 15 lb. Lambing is in January and February. Owing to the large number of twins, the Shropshire lambs do not reach consistent weights during the summer. When they are a year old, however, and fed off roots, they weigh about 80 lb. dead weight or more.

The Clun Owing to their relationship, the Cluns are often regarded as a hardy type of Shropshire. Apart from the "topping," their faces and legs are clean of wool, and are of the characteristic dark brown colour. The main differences are that the Cluns, though smaller, are a little higher in the leg and of a more "rangy" conformation, being lighter in the shoulders and a little narrower and longer in the head. All these points contribute to their hardy breeding qualities.

In moderately good situations, the lambs quickly mature. The wether lambs are usually sold as stores, and the ewe lambs (about half of which are expected to breed) are kept for stock. Afterwards the yearling ewes rear lamb crops of 150 per cent or more. On this basis it is possible to maintain self-replenishing flocks, while disposing of the regular draft ewes at the unusually early age of 2½ years. Naturally it leaves little scope for culling, which depends on the lamb crops, and the relative proportions of ewe and ram lambs.

Thus, many flocks comprise only two age groups, i.e., the ewe lambs and yearling ewes. There are no specialist ram-breeding flocks, though it is often customary to retain a few older ewes for this purpose. It is noteworthy that there is an almost complete change of ewes in alternate years, which sometimes leads to slight temporary variations in the type. Such changes, however, may be offset by the breeders' skill in selecting rams conforming to their ideal type, as well as by the effects of the local climate and "ground".

It is satisfactory to note that such a large number of flocks are registered. The Clun Forest Flock Book started in 1928. It is an "open" book, though regulations for registration on inspection are fairly strict. The chief sales are held at Craven Arms, Clun, Kingston, and other centres.

The Kerry Hill Many of the above points apply to the Kerry, making allowances for conditions. Descending from a hill type of stock, the Kerrys are hardier and more suited to poor land. One advantage is that the young lambs have a thicker birth coat, which is a help in bad lambing weather. The clean face and legs and distinctive black and white pattern of the Kerrys are well known. Breeders have devoted attention to these points, since they enhance the alert, gay appearance of the sheep, and are regarded as signs of constitutional hardiness and good foraging ability. They aim to breed for a cleaner face with clearly defined margins to the black and white pattern. Preferably, the black should be confined to an area round the mouth, and a splash on each side of the face near the eyes.

Like the question of "cover," these fancy points appear trivial, yet they are an important indication of purity of type. They add greatly to the uniformity of draft ewes, which appeal to the buyers, who prefer to breed a uniformly marked type of cross lambs. There is, incidentally, the additional question of appeal to the judges, since the prizes for the best pens of draft ewes of Kerrys (and Cluns) rank among the most coveted awards of stockmanship.

As the Kerrys are often kept in poorer situations than the Cluns, the lamb crops vary and may drop to, say, 120 per cent, instead of the usual 150 per cent, for two-year-old ewes. In poor situations the ewe lambs are generally too small for breeding in their first year and the drafting of ewes is therefore deferred for one or two years.

The Kerry Hill Flock Book, which is "open", was started in 1899. The chief sales are held at Kerry, Craven Arms, Knighton, and Kington.

Flock Management Clun and Kerry ewes in the Border country run chiefly on grass. Supplementary feeding is moderate and usually does not begin until the onset of bad weather. The ewe lambs, if in lamb, will require extra feed, such as a run on to some kale or sugar beet tops, or even a few oats. As lambing is in March and April, the general management is such that heavy lamb crops are raised on little more than good pasture.

Lambs are generally weaned fairly early, especially from the ewes to be sold as regular drafts, in order to allow time for them to freshen. The store lambs sometimes suffer by this and may make slower progress than, for example, cross lambs which have been weaned much later. As feeding sheep, the Cluns are reported to finish a little earlier than the Kerrys, though when properly fed on roots, "tegs" of the two breeds will grade 60 lb. dead weight and over.

The fact that the Clun and Kerry Flock Books are open leads one to consider the relationship of breed type with systems of flock registration and breeding policy. Flocks are registered on inspection, and may be accepted or rejected as a whole. Many breeders believe the open book is essential for occasionally introducing fresh blood, thereby safeguarding constitutional hardiness. Though unscrupulous persons may take unfair advantage of the opportunity, it seems to work out satisfactorily in practice. For instance, it permits a breeder with a light fall of ewe lambs to supplement them from a suitable commercial source, if possible from higher or poorer ground.

The chief disadvantage is that, following such introductions, their offspring may include good looking rams which may turn out disappointing breeders. This problem, however, may be misjudged unless viewed against the general background of breeding in the Border area. There is a keen following of both commercial and pedigree breeders, practically unhampered by conflicting ideals. The gradual movement of stock from the hills to the valleys is regarded as an important element in preserving the hardiness of the sheep, as well as in the capital appreciation in their value.

AGRICULTURAL EDUCATION IN SHROPSHIRE

H. Martin Wilson
Secretary, Shropshire Education Committee

In a county like Shropshire, agricultural education is a paramount service in its significance and potential fruit. The Shropshire Education Committee is deeply aware of its responsibilities—aware that knowledge of scientific developments, technical skill and training are quite as important as in any other industry, and that a well-educated rural community and a sympathetic urban population are of equal value.

The Committee's object is to build a structure of advisory and instructional work according to the needs of all in the industry—the young worker, the older man, the specialist, the man who is at an advanced stage and wants to study, for practical application, the latest results of scientific research and agricultural practice. The field of technical training to be covered is unusually diverse, and a variety of experiments are going on in Shropshire to lay good foundations for a comprehensive scheme.

The Place of the Farm Institute The focal point of technical agricultural education is the Farm Institute, and after much searching, since the Education Committee took over responsibility for agricultural education in 1945, a suitable farm and premises have at last been found at Walford Manor, some seven miles to the north of Shrewsbury. The Institute, which it is hoped to open in the autumn, will do work of the utmost value, not only for its regular fifty students a year, but for those who can come for short courses—farmers, young and old, and teachers—and in the advice its staff can offer and the part they themselves will play in classes and courses throughout the county and in helping the domestic grower and producer. The work inside the Farm Institute is only one part of the technical advice and training needed by the agricultural community. Outside it agricultural education must serve the young recruit, the workers who will never go into a Farm Institute, the many who have missed their opportunity, and the large number of groups and individuals with a special interest, the allotment-holders, keepers of pigs, poultry, bees, and other small livestock ; and the rural housewives, too, form a very important section of the community with their interest in the produce of the garden and its use, the preservation of fruit and vegetables, bacon curing, and the whole round of household economy.

Part-time Courses After the war the Committee found itself with no general agricultural staff. Nevertheless it was determined to make a full and realistic contribution to the needs of agriculture, and in this effort the farmers gave whole-hearted support. On technical agricultural subjects a good start has been made. In the first two years after the war, classes in tractor maintenance were established in over a dozen centres in the county. Last year, however, a broader front was opened up at a conference of representatives of the National Farmers' Union and the National Union of Agricultural Workers, and others interested. There was general agreement on the need for technical instruction, and the industry was willing to help. A series of small advisory working parties was set up on crop husbandry, animal husbandry, farm machinery, farm management, manual skills, the needs of the young worker, the needs of the smallholder and the hill farmer, to advise on the kinds of courses and subject-matter that would be suitable within their own particular field and to make proposals for lecturers and demonstrators. On the work of these meetings a substantial and varied programme of part-time courses was arranged last winter. These

courses have ranged from a group of three general or very practical lectures, perhaps arranged for the broad body of members of the individual Young Farmers' Club, to the longer series of nine in a market town centre or a wider area, for those who are prepared to specialize in a particular aspect of farming. The Committee works very closely with the keen and successful Young Farmers' Club movement, which it wants to see extended to cover the whole county. The next stage is to develop day-time classes at which the youngster can get a more solid course of instruction ; these will to some extent be the forerunner of the County College—the Day Continuation course which will later be compulsory for all. It has been noted before that in Shropshire some forms of special education can be offered only through residential courses, and these have had a particular appeal to the more knowledgeable young members of the farming industry. Mid-week, weekend and full week residential courses which have been specially arranged at Harper Adams College, the Shrewsbury Technical College and the new Residential Adult College at Attingham Park, have been strikingly successful and will undoubtedly be a permanent feature of future arrangements.

During the last winter over a thousand people, with a variety of needs, have attended the Committee's forty courses ; and allowing for all the vagaries of an experiment, it seems that they have made a useful contribution to the knowledge on which a comprehensive scheme will be built. For the success of these developments full tribute must be paid to the work and enthusiasm of the leading Shropshire farmers. The County branch of the N.F.U. has shown initiative, co-operating with the Committee, making proposals, and coming forward with the practical help of many individual farmers whenever the Committee asked for aid in formulating or executing its programme. The N.U.A.W., too, has been a keen supporter of educational activity. It augurs well for the future that the Education Service and the agriculturists are working together in closest co-operation and agreement to study and serve the interests of the countryside.

The Schools Technical education, however, is only one part of the Committee's responsibilities to agriculture. Those who come forward for agricultural education must themselves have a good educational foundation. We are long past the days when it was thought that any dullard would do for farming and that no special knowledge or ability or cultivation of faculties was necessary. It is a commonplace, too, that the rural Primary and Secondary Schools are at their most successful when they weave into their life and work the lore and skill and characteristic activities and interests of the countryside. Rural schools must have, according to their needs, equal opportunities with those of the towns and cities. They must be housed in good buildings, be well equipped and well staffed. Indeed the core of the problem is the recruitment of staff with a genuine feeling for country life and, in certain posts, with a knowledge of some of its distinctive pursuits. The Committee has long looked forward to the establishment of a number of modern schools in the rather larger villages and market towns as the keystone of good rural education—and also perhaps as the home of more general social and educational activity for the rest of the community, on the style of the Village College.

In some Secondary Schools pre-agricultural courses will extend the kind of work that has been carried out for the last four years in the Junior Agricultural Course at the Shrewsbury Technical College. The interest of the schools (including the town schools) is lively. There is distinguished work in gardening and rural activities. Farm visits are a regular feature of the school year ; farmers co-operate splendidly ; teacher and farmer work together to

get the greatest benefit from the farm visit and to make plain the underlying principles of farming practice ; and at the annual West Midland Show leading farmers now conduct parties of children round the exhibits.

The Committee is continuing to develop its rural advice services to schools and refresher courses for teachers on agricultural subjects and the general educational problems of the country school.

The flow of country boys and girls into urban occupations is no longer a one-way stream ; town boys are becoming increasingly interested in agriculture as a career. The town school can evoke a live interest in the countryside by fostering an understanding of the foundations of our economic health and survival, for the activities of the countryside are of the essence of man's primary needs.

Country Life The education service also has a part to play in meeting the wider demands of the country dweller. Hobby classes are offered, and the number of Evening Institutes increases. The Committee's staff is always ready to help on the good work of the Women's Institutes, and young people are encouraged to healthy activity through youth clubs established in most villages. The County Library has begun to serve the country reader almost on his doorstep with a Travelling Library. Drama and music are encouraged in the villages, and by festivals. Birmingham University and the Workers' Educational Association carry their programmes of adult education into the country areas, and the Walker Trustees (executing the will of a Shropshire ironmaster), the Carnegie Trustees, the University and the Education Committee have co-operated to establish a residential college in a fine Shropshire mansion, Attingham Park, three miles from Shrewsbury, open to all classes and all interests, for day, weekend and week courses and conferences, and designed to be a focus of the cultural life of the county. Attingham will, it is hoped, be the centre of the network of adult education throughout Shropshire ; other experiments are going on in the establishment of area tutors, each responsible for a section of the county.

All concerned with this work, both technical and general, have a keen appreciation of its ultimate importance to the nation, for upon it and similar work in other counties rests the physical and spiritual well-being of our people.

BILLHOOKS AND SLASHERS

James White

Rural Industries Bureau

THE very names of these edge-tools are reminiscent of a fine and enduring tradition which is rooted deep in the English countryside. Of the infinite variety of billhooks, many take their names from their places of origin, such as the Tenterden billhook, which has a sweeping curve like the beak of an eagle, or the stubbier Kent billhook. The Norfolk hook has a straight spine and gently curving edge, and the Stafford broomhook has an additional short cutting edge on the spine. Then there is the Irish slasher, a magnificent double-edged tool, and Sir Tatton Sykes gives his name to a long straight-edged slasher. There are slashers for hedges, slashers for gorse, and slashers for beans. The smooth combination of their curves gives each one a grace of its own. For generations the craftsman has sought to suit the tool to the hand which uses it and to match it to its purpose.

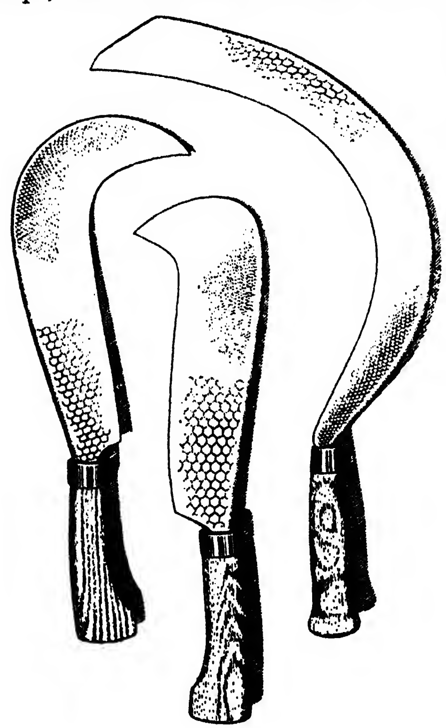
To those who use these tools all day long and day after day, these qualities of balance and edge are of supreme importance. The weekend

gardener who merely wants to trim a short hedge is content to slash for twenty minutes with a crude machine-made tool. But the forester and the underwood worker who will use the tool for many hours on end will always try to acquire one hand-made by a skilled smith.

Unfortunately the hand-made tool is hard to find these days. The main reason is that the iron of high quality which was converted into blister steel and used for hooks and slashers came from Sweden. This iron is now difficult to obtain and very expensive. Substitutes have been tried but they are not satisfactory because they do not give the same fine cutting edge.

This Swedish iron bar is commercial iron in its highest state of purity and is worked by a special process. The iron is heated almost to melting point, and controlled quantities of carbon are worked into its surface. The heated steel is then folded like pastry and forged together in order to incorporate the carbon in its structure. According to the number of times this is done, the steel is known as single or double shear. Woodmen, thatchers and farmers still demand tools such as riphooks, billhooks, slashers, thatch knives, etc., made from this steel. They claim that tools forged from double-shear blister steel retain their cutting edges far longer than the machine-made tools of carbon steel. Tools made from blister steel sharpen with a characteristic wavy edge, which is caused by the alternating hard and soft structure of the steel, and in that form they wear better. Possibly the wavy edge gives a slight sawing quality to the cut and makes it more efficient. Whatever may be the explanation of this irregular cutting quality, the craftsmen who use the tools are emphatic in their preference for this material, which is worked into an implement of perfect balance and requisite shape by a skilled smith.

One of the ways in which smiths obtained suitable steel was to use old rasps, which were heated to give them strength and tempered to keep the sharpness of the edge. Tools made in this way (as those shown here) usually retain the pattern of the original rasp, which survives faintly on the surface like fish scales. But since the supply of old rasps is limited a great quantity of tools cannot be produced in this way.



A fine edge of sufficient strength can also be obtained by using layered steel. The centre filling is hard and gives a good edge, but it is brittle ; a milder steel is therefore used on either side in order to strengthen the blade. These two types of steel combine to give the characteristics of a keen edge and a strong blade. The blade is then drawn out under the hammer, tempered, and ground.

Because foresters and woodmen still seek these hand-made edge tools the Royal Agricultural Society is this year holding a competition at the Royal Show for the best billhooks and slashers

made by a smith. The tool must be hand-made, but the smith will be allowed to use the power hammer, which requires quite as much skill as the hand hammer. The judges will be Mr. P. E. Barnes, Head Forester of the Penrhyn Estate, N. Wales, and Mr. A. W. Williams, Chief Technical Officer of the Rural Industries Bureau. It is hoped that the competition will stimulate rural smiths to make these high quality tools and so meet the need of foresters. The hand-made tool is slightly more expensive than its machine-made cousin but its advantages to the forester in quality justify every effort being made to maintain the smiths' skill in this particular direction. The display of these magnificent tools should arouse considerable interest among all those who use them, if for no other reason than the divergence of preferences and opinions which exists about their design.

A billhook that is considered the best possible shape in the West of England may be rejected with "contempt" as an altogether useless tool in the eastern counties However, the judges have sufficient technical knowledge to award the laurels where they are most deserved.

BOOK REVIEWS

Cherries. NORMAN H. GRUBB. Crosby Lockwood. 30s.

No book on fruit-growing published of recent years has contained more information in such compact form ; as a work of reference it sets a new standard in fruit-growing literature. The author has had a unique opportunity of combining a detailed experience of commercial cherry-growing, not only in Kent but elsewhere, with research into problems of cherry culture at the East Malling Research Station, and his book, backed by the experience of a lifetime, has obviously been compiled with the same sincerity and meticulous care that have characterized his researches into a wide field of fruit-growing problems.

Cherries have been grown commercially in England for many generations, and a fund of knowledge exists in orchard practice. The fastidiousness of this fruit as to soil and climate is well known, but it is only lately that such problems as pollination and of rootstock have been sufficiently understood to improve beyond measure the prospect of success in cherry orcharding.

Part I deals concisely, yet adequately, with those considerations of site, soil and climate which have had a marked influence on the distribution of the cherry-growing areas of England, and Chapter IV (Propagation and Rootstocks) condenses all available information on a subject fundamental to success in tree production and growth. Apparently the chances of a dwarfing cherry rootstock comparable to M.IX are at present remote, but Mr. Grubb is hopeful that one will come to light in the future through investigations now proceeding on the problem. Sound and clear advice is given on orchard planning and management, pollination and the choice of varieties.

Part II, occupying by far the greater part of the book, will unquestionably prove of enormous value to grower, research worker and student, as the standard work on the identification and description of cherry varieties. With few exceptions, the descriptions of varieties are written from actual knowledge and sight of the sorts named.

A confused nomenclature has been a serious obstacle to success in the industry in the past ; the author's information on species and groups of cherries, description and identification of varieties, together with the twenty-eight photographic plates (some in colour), will be of inestimable value.

E.W.H.

BOOK REVIEWS

The West of England. RUTH MANNING-SANDERS. Batsford. 12s. 6d.

As a guide to the delights of Cornwall, Devon, Somerset and the Isles of Scilly, this latest volume in Batsford's *Face of Britain* series would be difficult to surpass. The author writes attractively and with an intimate knowledge of her ground, and the publishers have ably supported her by a good presentation. There are over a hundred photographic illustrations. The book will be of interest equally to those who know this part of England and to those who do not; for the one, besides renewing old acquaintances, may well find mention of some little corner, a sequestered hamlet, some church, or scrap of history that has so far escaped him; the other, because a world of interest and charm is opened up in such graceful, even seductive, language.

The author contrasts, for example, the grim austere Bodmin moor in Cornwall "... where there is nothing but thin grass, heather, granite-rough hills, little ponies, small, black, hornless cattle, bogs, pools, a few china-clay dumps, and the moaning of the fiend-pursued spirit of Tregeagle", with Dartmoor, lying across the border, which comes out of its mists to reveal an infinite variety of shape and colour, and a genial, invigorating atmosphere. Here is "a world of superb landscapes and glowing colour, swift golden rivers, shining valleys and great hills that are pointed and individualized by their towers of granite; a world, too, of vast bogs, and acres of peat, slashed and furrowed like any battlefield by heavy rains. Here storm-clouds topple among the hills and rain falls swiftly, to be rent as swiftly by glittering sunshine . . . Down below the sunlight sparkles on every rain-beaded twig and bracken frond, and in the drenched thickets whitethroats are merrily singing. There are, perhaps, no grander skyscapes to be seen anywhere in England".

This book is alive with such verbal beauty and adds considerably to the inherent interest of this corner of England, which the author describes so well.

S.R.O'H.

Shropshire. EDMUND VALE. Robert Hale. 15s.

Worcestershire. L. T. C. ROLT. Robert Hale. 15s.

In the same genre are these two *County* books from the Robert Hale press, and if we may judge the series from the sample, it will be well and widely received. We seldom outgrow the feeling of loyalty for our native county and, if the truth be admitted, it often leads us into extravagant claims on the one hand and deprecation of another's merits on the other. The latter, more often than not, may be the result of imperfect knowledge, and to this these *County Books* will be a useful corrective.

No "proud Salopian" will have cause, I think, to accuse Mr. Vale of doing less than justice to the claims of Shropshire, despite the author's cautionary foreword. Within its 1,346 sq. miles there is a wealth of varied beauty, natural and man-made, that yet bears the impress of history and tradition. Admitted that some part of the spirit which pervaded the Shropshire countryside before the war has been dissipated by the austerity of our time, but "though much is taken, much abides"; the elements of rural life are still conserved, as in Corvedale, for example, where the Celtic-sprinkled dialect is still alive and the rising generation is bilingual.

Of Shrewsbury itself, one of the noblest of old English cities, Mr. Vale claims it as "a peculiar instance of a town which history has served well at almost every turn". Conscious of its heritage, it brings its past glories forward to serve the practical needs of the present. The quaintness of the ancient "struts" and "gullets" which run between the houses never fails to delight the newcomer to Shrewsbury, but if at one end the visitor finds himself in the romantic, half-timbered world of Elizabethan and Jacobean buildings, at the other he will find essentially practical, smart, modern shops.

Across the border, Worcestershire, less than a quarter the size of Shropshire, has a character all its own—the character which evoked the nostalgia of F. W. Harvey from Flanders in the first World War:

I'm homesick for my hills again,
My hills again!
Cotswold or Malvern, sun or rain!
My hills again!

He remembered the red soil, patterned by fruit plantations, the rising dark slope of Wyre, the foothills of the Shropshire Clees, Titterstone and Abdon Burf, and the Severn, nourished by the Avon, sliding majestically from north to south through lush meadows to the sea. Mr. Rolt's approach to his subject is primarily historical and sociological, taking in the topography as he goes. This is unusual in a book of this nature, but the result fully justifies the method. It presents the natural beauty of the countryside—and, no less, the ugliness of some of the industrial towns in the north—in terms of what man has made of his heritage. And that, after all, is the stuff of history and the measure by which we ourselves will be judged by the generations that come after.

S.R.O'H.

Fream's Elements of Agriculture. (13th Edition). Revised and Edited by D. H. ROBINSON (1949). John Murray. 21s.

A farm book-shelf without a copy of Fream's is akin to a farm without a plough, and when Dr. William Fream first published his textbook in 1892 it is unlikely that he anticipated the success that would attend his efforts.

There can be very few students who have passed through the universities, colleges and institutes of this country without meeting this veritable encyclopaedia of the science and practice of British agriculture. Since the first edition, the work has been revised many times and the 12th edition was entrusted to the staff of the Cambridge School of Agriculture, in 1932, under the editorship of Sir Rowland Biffen. Since 1932 great progress has been made in every aspect of British farming, and the Royal Agricultural Society of England quite rightly determined at the end of the second world war that a completely new edition was necessary. The editorial work was entrusted to Dr. D. H. Robinson, who, assisted by a team of specialists in the different branches of agriculture, has entirely rewritten the work, which is now illustrated with over a 100 text drawings and 116 excellent photographs.

A new chapter on buildings and permanent equipment has been added, special attention has been given to the use of mechanical power in farming, and a great deal of useful information has been summarized in a series of five appendixes. There is also an adequate index. The illustrations merit special note, especially those covering some of the insect pests.

The text is extremely readable and authoritative, and can be thoroughly recommended to all students at agricultural colleges, institutes and schools who need a reliable textbook covering the whole subject. Farmers who wish to gain an all-round general knowledge of agricultural science will find that this new edition meets their needs admirably. Indeed it is one of the best investments that anyone interested in the land can make. *H.I.M.*

Journal of the British Grassland Society, Vol. 4, No. 1 (March, 1948).

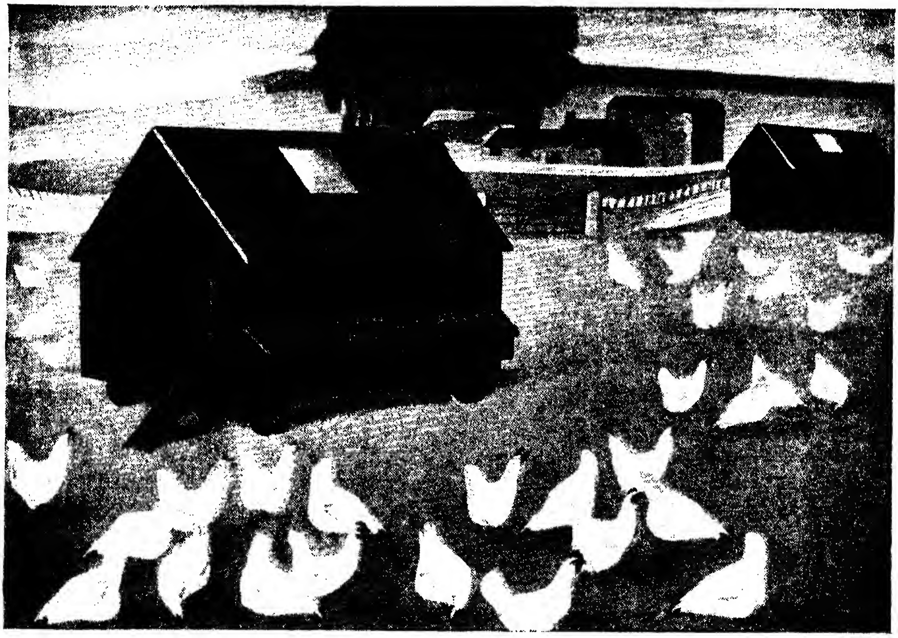
Two papers in the latest issue of the British Grassland Society's Journal deal with field experimentation as applied to grassland. Dr. D. A. Boyd in a paper entitled "Experiments with Leys and Permanent Grass" discusses factors affecting the technique and design of grassland experiments and illustrates his points with a description of a new experiment being laid down at Rothamsted. A paper by J. O. Green discusses herbage sampling errors and the possibility of reducing such errors in grazing trials. Two further papers deal with pasture evaluation. T. E. Williams discusses possible methods of quantitative grassland evaluation. Little work has so far been done in this direction and the possibilities of various methods are examined. He deals at greater length with qualitative evaluation by botanical classification; the method which has been largely used in assessing the productivity of grasslands in this country. A. Jantti, a Finnish Research Worker, describes a statistical estimation of the output of different types of pasture in Finland, based on a country-wide statistical investigation. Dr. R. O. Whyte contributes an interesting account of the problems of fodder production under conditions of primitive agriculture in a Mediterranean environment with special reference to Cyprus, and discusses the difficulties involved in providing a balanced form of agriculture under these conditions.

An investigation into the establishment of autumn-sown legumes is described by Betty F. Martin, and the results confirm the difficulty of their establishment. The question of suitable species for use in the reseeding of land which is frequently subjected to prolonged flooding is a matter requiring further investigation. The last-named author, with A. G. Davies, describes a pilot experiment to test the effect of artificial flooding on certain grass species. *W.E.J.*

Printed in Great Britain under the authority of HIS MAJESTY'S STATIONERY OFFICE by C. Nicholls & Company Ltd., The Philips Park Press, Manchester, London and Reading.

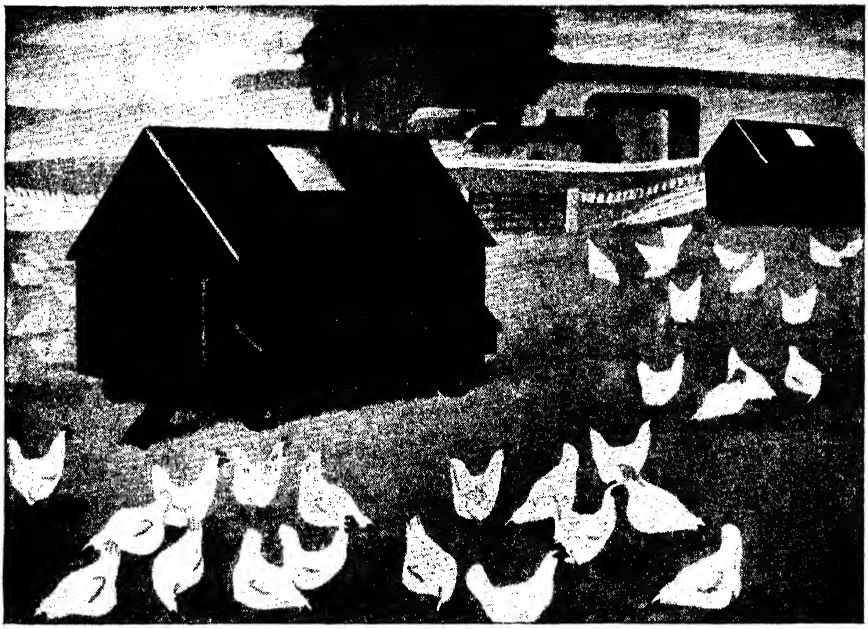
Please mention the JOURNAL *when corresponding with Advertisers*

Please mention the JOURNAL *when corresponding with Advertisers*



Agriculture

PUBLISHED 6d MONTHLY



AGRICULTURE

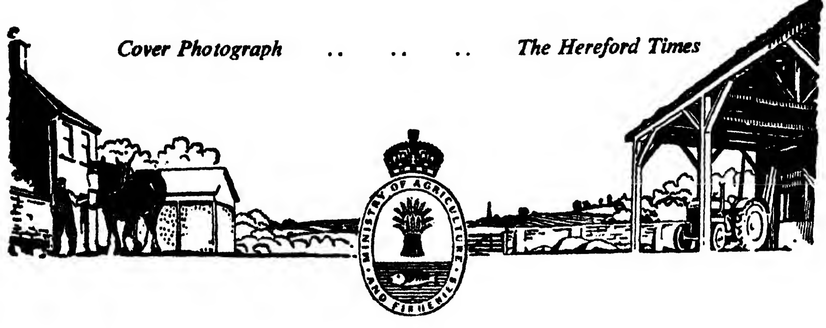
THE JOURNAL OF THE MINISTRY OF AGRICULTURE

Editorial Offices: St. Andrew's Place, Regent's Park, N.W.1 (*Phone: WELbeck* 7711)

VOL. LVI No. 5 AUGUST 1949

Contents

Cover Photograph .. .. .. *The Hereford Times*



AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LVI No. 5 AUGUST 1949

MORE CORN

THERE is, as is well known, deep anxiety about our present economic position and still more about what may happen to us in three years' time when Marshall Aid comes to an end. Despite the large measure of help that we have got and are getting from the United States and Canada, our small reserves of gold and dollars have lately been slipping away at an alarming rate. In other words, so far as dollars are concerned, we are living beyond our means.

Various things have already been done to reduce the drain on our bank balance, including a substantial cut in imports of raw materials and other things from dollar countries, but these do not alter the fact that we are faced with a clear choice ; either we must, by one means or another, achieve a substantial increase both in our industrial exports and in our home production of food before 1952, or we must then reconcile ourselves to a substantial fall in our whole standard of living.

The part that our own farming industry was called to play in national recovery was set out, two years ago, in the Agricultural Expansion Programme. We were to increase our output of food until, by 1952, it should be half as much again as it was in the pre-war years, and thereafter it was to be kept at this new level. This was, admittedly, an ambitious plan ; but the organizations of farmers and workers alike agreed that it was within their powers to carry it out.

Part of the increased production was to be achieved by better all-round farming—by raising our average yields of wheat, potatoes and other crops and by getting more milk per cow, more eggs per hen, and so forth. But it was necessary to seek further ways of getting still more of those things which, if we do not produce them ourselves, must either be bought for dollars or not bought at all. The chief of these are meat, fresh meat, and bacon.

In surveying the possibilities of higher production it seemed to the Ministry that the greatest opportunity was offered by our grasslands—by ploughing out and reseeding in the hills and other marginal areas and by changing over elsewhere to ley farming wherever arable crops could be grown successfully. It seemed too that our grassland, through the development of ensilage and grass drying, could contribute substantially more, especially in protein, to the winter feeding of our livestock. These things are coming to pass. We have much upland pasture and rough grazing that could be converted into something far better, and we have still a deal of poor old grass on land that could be farmed, with much higher production, on the ley system. But good progress is being made.

It was, however, obvious from the outset that if grassland development went according to plan and if the old acreage were maintained, we should soon have more grass than we could stock. The calf subsidy was introduced in order to encourage the rearing of all calves that had the makings of useful beef, and it has largely succeeded in its object. But even so, the increase in

cattle herds must, in the nature of things, be slow; it cannot conceivably keep pace with the rate of grassland improvement that is possible and that is needed. It is unlikely that the increased supply of Irish stores will fill the gap. In theory, sheep numbers can be built up much faster, and in a few counties expansion is now rapid. Elsewhere, however, serious difficulties stand in the way—especially the lack of fencing for grass flocks and the scarcity of skilled shepherds. We can still increase the breeding and rearing of meat animals but the indications are that the supply of grazing stock will not be enough fully to stock next year's grass, assuming an average season; and understocking is the surest and quickest way to undo our own efforts to maintain highly productive swards. Moreover, in a reserve of silage we have a good insurance against summer drought.

In short, the object of the grassland development programme is to enable us to keep more stock, and do them better, *on fewer acres*.

What then shall we do with the land that can thus be spared? In the wet uplands of the west, where only a small acreage of corn can be saved with the amount of good harvest weather that is to be expected, rape can be grown to fatten lambs and flush ewes, and more kale can be grown to supplement silage and hay. In these areas one of the chief needs is to secure a better balance between winter and summer keep, and particularly to carry the young stock round to the spring in healthy thriving condition. In other areas, the spare land should be used, in the main, to grow more corn.

It is here that we are failing to implement the expansion programme. This year's wheat acreage will be little more than two million acres, whereas our target was 2,500,000. The short-fall is thus about 20 per cent. Last autumn was, of course, a difficult time, with a dragged-out grain harvest and a full acreage of sugar beet and a record acreage (and tonnage) of potatoes to lift. Reduced autumn sowings were to be expected, but it was hoped that a considerable part of the short-fall would be made good by extra spring plantings for which a dry and mild February gave every opportunity. But this did not happen. It seems that many farmers still look upon spring wheat as an unreliable and, on average, an unprofitable crop—as indeed it used to be. But there is plenty of evidence, especially from the Midlands and West, that the newer spring varieties will, taking one year with another, yield just as well as the winter sorts.

Even with an overall deficiency in wheat, the loss could have been largely made good by bigger sowings of barley and oats. But these did not materialize. Indeed, the area sown with these grains fell short, by 150,000 acres, of the target.

The importance of maximum wheat production is obvious; the dollar countries are the only source from which we can make good any deficiency. The importance of coarse grains is less obvious because we may, under certain circumstances, and in some seasons, be able to buy, at a price, very considerable quantities without spending dollars. We were fortunate in being able to do so last year, and we have been fortunate again in making contracts to cover our requirements, our present ration scales, for the coming year. But we should be foolish if we continued to expand our pig and poultry production on the assumption that we can get equal or greater supplies in the future. Our sources are too unreliable. We must, from next year onwards, produce more of the necessary grain from our own soil. It has already been announced that the standard of self-sufficiency for dairy cows for rationing purposes will have to be raised from October 1, 1950. On most farms this can best be achieved by increased usage of silage or dried grass, of which larger quantities are being made each year. We must, however, also strive to carry the increasing numbers of pigs and poultry as well as cattle.

It would be futile to deny that there are real and substantial difficulties in raising our tillage acreage and particularly that of corn. In those counties where there was wholesale grassing down from the eighteen eighties till the 'thirties (and where we must look for much of the extra tillage), farmers will find it difficult—even with full mechanization—to get together a sufficient force of skilled regular labour. The combine is indeed solving the problem of labour for harvest and threshing, but is creating a problem of drying and storage. But the other doubts and fears that are expressed are less well founded, and some are based on misunderstanding. One such misunderstanding is that the expansion programme is billed to come to an end in 1953, and that the tillage acreage may then begin to decline. If this were so it would indeed be unreasonable to expect landowners to erect new buildings or to ask farmers to equip themselves to handle a higher acreage of tillage. But so far as it is possible to foresee the future, a high intensity of production will have to be maintained for very many years to come. The food outlook for the world at large is such that we cannot reasonably expect a return to the conditions that prevailed in the 'thirties, when other countries were pressing their food surpluses upon our market. The expansion programme is only a stage in a long-term effort towards greater self-sufficiency.

Farmers have expressed anxiety about the high incidence of soil-borne diseases of wheat—Take-all and Eyespot—both last year and this. There is no doubt that in certain districts losses have been severe. But it is by no means certain that there has been a progressive build-up of these troubles or that they would have been less severe if acreage targets had been lower. The main explanation of recent outbreaks is to be found in weather conditions; damage is always highest after mild winters. No cure for the trouble is in sight. But serious damage is very rare, except where meat has followed wheat or barley. Such a sequence of crops, which is rarely good farming, should never be followed on land that is subject to Take-all, and is not required by the existing targets.

Again, it is sometimes argued that wheat is an exhausting crop and that the target acreage cannot be obtained without a progressive decline in soil fertility. But it is hard to convince oneself that a target acreage of 2,500,000 acres, spread out with proper regard to the nature of the soil and climate, is more than is compatible with good husbandry. Even if we make allowance for the land that has been lost to farming in the past eighty years, it is a considerably smaller acreage than our grandfathers grew; they paid great regard to the rules of good husbandry and they had fewer resources, in the way of fertilizers, than we have today, and we have in the modern ley another means of keeping our land in good heart.

There is admittedly a good deal of light land that must be specially prepared if it is to carry a full wheat crop. On such land we must expect a high ratio of barley in the east and of oats in the west. But the produce from such crops, in so far as they are sold by the grower, will make a most valuable contribution to the feedingstuffs pool. The farmer who does not have wheat land can thus nevertheless help greatly towards the achievement of the overall increase in output.

The Minister concluded his recent broadcast appeal with the following words:

"The people of this country are looking to our farmers for a successful outcome of the task to which they have put their hand. In the national interest, and in the interests of our agricultural industry itself, we must see that the job we have to do is well-planned, well founded and well balanced. I ask you to think it over most carefully when you are preparing your cropping plans for 1950. And again ask yourself the simple question 'Am I really playing my part in this Programme: and if not, why not?'."

FEAR OF WORLD HUNGER

SIR E. JOHN RUSSELL, O.B.E., D.Sc., F.R.S.

IT is currently accepted that the world's population is increasing more rapidly than its power of producing food. The coloured peoples and those of Eastern Europe increase much more rapidly than those in the West. Among the Western nations, it is usually the lower income groups that multiply most quickly. The anticipated result is a progressive deterioration in quality of the populations but an increase in quantity. This part of the forecast must be left to population experts. Only the second part, that the world food production resources are nearing their limit, is dealt with here.

It is, of course, a fact that land capable of or actually producing food is lost to cultivation every year; also that no large areas of land suitable for settlement by Europeans are now available. Nevertheless, there is still land that could be used, and much of the existing cultivation could be intensified.

Accurate figures are not known, but the world's population is about 2,000 million, and the annual increase about 20 million. The area of land having climate suitable for crop production is about 11,500 million acres—about 5 acres per head of world population. This, however, includes great tracts of almost impossible soils, while the area actually producing food is of the order of 2,000 or 3,000 million acres—about 7 per cent of the total land surface. The tillage figure is indefinite because of the wide latitude given to the term "grazing land". But accepting the data as they stand, the average allocation of cultivated land per head for the world is at present about 1 or $1\frac{1}{4}$ acres per head. In Europe, about 1.5 to 1.8 acres suffice per head of population, and in the vegetarian countries of the East about half this area, or less.

It is estimated that some two-thirds of the world's population are food producers, most of them peasants, and all experience shows that the food producer is the last to go hungry when trouble comes. The food problem is therefore of unequal incidence; it presses hardest on the crowded lands, where a large part of the population is either non-agricultural or, if on the land, redundant. The three chief regions are north-west Europe, including Great Britain and Italy, India, and east Asia, including Japan and part of China. Elsewhere the possibilities of food production are still adequate even though they may not be fully used.

Wheat Area Potential The chief food imports of north-west Europe and Italy before the war were cereals and oil seeds, but we needed meat and dairy products also. On the average, continental Europe, before the war, imported from outside its borders 11.1 million tons of grains per year, including 3.7 million tons of bread grains. But we imported no less than 9.75 million tons of grains, of which 5.6 millions were bread grains. The war upset the very efficient arrangements by which this commerce was carried on, and new ones have been set up. The grain areas of the great wheat-growing countries of Europe, France, Italy, and Spain are, or were until recently, still below their pre-war acreage, as also were those of Germany, Hungary, and Roumania. The countries of north-west Europe can no longer rely on supplies from eastern Europe. They must look to the Americas and Australia, and now compete with us. Can these countries increase their supplies to satisfy the new demands?

The reports of the Food and Agriculture Organization indicate that the world acreage of wheat, which in most countries had fallen to a minimum in 1943, had by 1946 attained its pre-war value of something over 365 million acres; but in the meantime, of course, the world population had increased. Argentine and Australia are not yet up to their pre-war areas. Canada has a little more, and the United States still more than pre-war. This failure to

increase the world area of wheat since the 1934-38 period has been interpreted as showing that all the wheat lands of the world are occupied. But there was a similar standstill between 1909 and 1924, when the world acreage remained steady at about 280 millions; thereafter it rose steadily until 1937, when it reached 365 millions. The block is probably due to limitations of transport and storage facilities, and until a market seems assured, i.e., until the food is needed, no one is prepared to incur the considerable cost of providing more. For the same reason there has been a similar stagnation in areas under barley, oats, and maize.

Sir William Crookes, in his Presidential address to the British Association in 1898, declared that the wheat areas of the world were almost fully exploited, and after the 1930s the world would begin to suffer hunger unless yields were increased. With true scientific insight, he indicated the way out: the synthetic production of nitrogenous fertilizers. This was duly accomplished and has led to a great increase in food production and saved us from hunger during the two wars and after. But the wheat lands were not exhausted, and indeed they have expanded greatly since his time. Canada, in 1898, had 4 million acres of wheat; in 1940 it had 28 million; and its present acreage is 24 million. Australia in 1898 had under 5 million, but in 1947 had 14 million acres. This quite unexpected expansion arose from the success of the plant breeders in producing new varieties of wheat better able than the old ones to grow in regions of low rainfall; in consequence, the wheat zone was pushed more and more into the dry regions, and also into the northern regions of shorter summers. At first the plant breeders' work was purely empirical and, while much success was achieved, there were difficulties which could not be overcome, especially in regard to Rust. The development of modern genetics has greatly strengthened the plant breeders' powers of attacking problems, and after years of research the Minnesota workers, under Professor Stackman, and the Canadian Rust Research workers have now produced varieties more resistant to Rust than any before. It is quite impossible to forecast how far this wheat breeding work can go, but modern science can hardly fail to produce still more drought- and disease-resistant varieties suitable for still drier regions, and varieties that can be pushed further northwards. Crossing with *agropyron* (couch grass) is claimed by Tsitsin to do all this, and the claims are being studied in Canada.

Conservation A great difficulty about expansion into the dry regions is the liability to soil erosion: soil drifting where the rainfall is less than about 12 inches per annum, gully erosion when it is more. Undeniably, much land has been lost in this way; in many cases, however, not beyond hope of recovery. Methods of prevention and cure are known, and the Food and Agriculture Organization reports that the importance of soil conservation is being increasingly realized, though progress is not infrequently retarded by shortage of staff and materials. In the United States and in most parts of the British Commonwealth considerable action has been taken; to a greater or less extent forty-nine countries are doing something. The "conservation districts" of the United States, where proper preventive measures are adopted, have increased from 36 million acres in 1938 to 1,112 million acres in 1948, and by nearly 2 million acres in Puerto Rico. Active conservation plans are in operation on nearly 158 million acres, and the "treated area" is 83 million acres. Dr. Bennett, Chief of the Soil Conservation Service, in his report for 1948 writes: "By sharply increasing our present conservation operations on the land we can overcome and control erosion within twenty or thirty years." Even in the United States, however, conservation has not yet overtaken deterioration; still less has it done so in

other countries. In any case it is a slower process, and action therefore has to be on an adequate scale.

One of the most important agents in conservation and rehabilitation is grass, which is just as valuable in the dry regions of the world as in the wet. As with wheat when it was pushed into the dry regions, so with grass; the first step is to find suitable varieties, then by selection and breeding to improve them. Since these dry regions are used more for grazing than for cropping, it is necessary to find grasses or leguminous plants suitable not only for soil conservation but also for grazing, though, of course, soil conservation comes first. Active research on this subject is in progress in the United States, Canada, Australia, New Zealand, South Africa, and elsewhere. The Soil Conservation Service of the United States recently surveyed four Western States and found only 5 per cent of the range producing its maximum output, while no more than 10 to 15 per cent was in good condition; on some 70 to 80 per cent of the range, forage production could be doubled with proper conservation practices. Similar results could be widely found elsewhere. The Australian work on range improvement has been summarized recently by Dr. Trumble in his book *Blades of Grass*; but the excellent work of Dr. Pole Evans in South Africa is not as well known as it deserves to be. He has searched the dry regions of Africa for drought-resistant grasses and found a number that are good both for grazing and soil conservation. His collection is planted near Pretoria, and it is greatly to be hoped that the necessary breeding and selection work can be carried out. Proper management of the grazing is, of course, essential.

Tropical Contribution The tropics contain large areas of land capable of producing much more food than at present, but they present special and often very difficult problems, not only technical, but human as well.

In the wet Tropics, plantation crops—tea, rubber, palm oil, etc.—grown under British or Western European supervision have given considerable knowledge of the scientific and technical problems involved, and shown the need for treating the region as a whole, i.e., putting the permanent crops on the high ground which is subject to leaching and erosion, and the annual crops, such as swamp rice, on the low ground. The proposed UNESCO survey of the forestal regions of the Amazon valley, if carried out, should show how this vast region could ultimately be utilized. The African savannah regions of seasonal rainfall are already being developed for oil seeds and other tropical crops, and this work has been helped greatly by the modern insecticides which enable noxious insects, tsetse fly and others, to be controlled. The disc plough and modern large implements have made large-scale operations possible, and though difficulties still remain, they are likely to be more on the human than on the technical side.

At the other end of the climatic scale much progress has been made in this country in utilizing high-lying land that had long been almost waste (though much of it was used in the nineteenth century), and in Sweden, Finland and Russia in extending the region of cultivation northwards and getting higher output from the podsols. It seems unlikely that all these efforts to expand the present small area of the world's cultivated land will fail.

Intensive Cultivation of Existing Land There is, however, greater scope for increased food production by intensifying cultivation of existing land. More than half the world's food producers are working on very primitive methods and obtaining very poor yields. The old medieval grain-fallow

system, discarded here in the eighteenth century, is still widely practised in the peasant countries, with other systems equally inefficient. We doubled our yields when a proper rotation was substituted and livestock husbandry fused with arable husbandry, and further, the way was opened up for greater intensification. Considerable increases could undoubtedly be obtained by similar methods in the peasant countries. There are, of course, difficulties, both technical and political; they include the provision of a proper system of land tenure, of education, of buildings, roads, water and farming appliances; particularly some measure of industrialization to take redundant people off the land and set them to produce the appliances the farmer needs. Before the war Czechoslovakia and Poland had both gone well on the way to do this. In India the experimental farms regularly obtain at least double the neighbouring peasants' yields. Even in our own country the most progressive farmers obtain well above the average outputs of comparable land. Once a suitable system is devised and responsive varieties of crops and stock found, the biggest advances can be expected from a fuller and better use of fertilizers. Their consumption is greatly increasing, but only a few countries as yet make adequate use of them. Finally, there are still great losses of crops and animals on the farm, and of produce between the farm and the consumer's table. Various estimates have been made of the losses involved, some little more than intelligent guesses, but others, such as the short life of a milking cow in the herd, are based on ascertained facts. The total is impressive. Fortunately great efforts are now being made to reduce these losses, and the recent addition of biochemistry to the list of sciences aiding agriculture, which has already given us selective weed-killers, tomato-setting hormones, oestrogens, anti-biotics, etc., promises still further achievements.

There is no room for complacency, but certainly none for despair; and with intelligence and hard work the food problem for our generation can be solved. All the same the shrill sensationalism of some of the pessimistic writers will serve a useful purpose if it arouses a widespread determination to keep our own meagre allowance of agricultural land as nearly intact as possible.

GRASS SILAGE FOR SHEEP

J. Stawart

Wooler, Northumberland

After two years' experience of feeding silage to sheep in replacement of roots, there is no doubt in my mind that it is a very practical proposition, provided a few simple rules are observed. The first, and possibly the most important, is that the silage must have been made from short grass, of very good quality and free from mould or sourness. A sheep is much more particular in its feeding than a bullock, and to attempt to save time or labour by careless selection and making will result only in waste of material and disappointment. Secondly, it is very desirable that the change from any other feed to grass silage should be made gradually—introducing into the sheep's feed only small quantities until the change-over is complete. For example, one may have sheep folded on rape or kale in the autumn and wish

either to feed them off on silage or carry them through the winter as stores. In either case a proportion of hay can be fed with either of the crops mentioned and so get the sheep accustomed to feeding from a hay-rack. It is then only a matter of gradually substituting silage for hay, and when the animals have reached the stage of running to the rack as soon as it is filled with silage, it can be assumed that it is safe to change over completely to silage in place of the grazing crop.

So far, all my grass silage for sheep has been made with molasses, but I don't think this is essential. The results obtained by using a small tower type of silo have been very satisfactory, partly because silage made in this way is not quite so damp as that made in a pit and partly because of the greater heat generated. The product may be less digestible but it is more palatable.

When the pit or tower silo is opened, protection from wet weather can be secured by covering the top of the silo with straw, avoiding any depression in the middle which might hold water. I have found that no surface of silage should be exposed to the air for more than three days, otherwise it will start to mould.

Feeding Practice In feeding grass silage to sheep, it is unwise to lay down any hard and fast rules as to quantities. This is a matter which depends primarily upon the relation of silage to other food available. My experiments have been made to avoid the use of root crops for the feeding and storing of sheep during the winter months and to reduce the consumption of hay and expensive protein foods. My normal practice with feeding sheep is to fold them on rape or kale from about the beginning of November until the beginning of December, when the change-over to silage is started. By the middle of December the change-over is complete and within a month selling begins. In 1947 about 160 feeding lambs went on to grass silage in December and, even though these were in good condition at the time of the change-over, weighing 124 lb. live weight, the average killing-out weight of 69 lb. at top grade gives a very satisfactory liveweight gain per week during the five weeks they were on silage. In 1948 the same procedure was followed, and this time 204 lambs were changed over from rape to grass silage on December 8. In this case the average weight of all lambs sold between the time of going on to silage and February 14, 1949, was 67 lb. (carcass weight).

It has not been my aim to dispense with concentrates entirely in the feeding of sheep, but rather to substitute grass silage for turnips and to make full use of home-grown cereals. I think that there can be some saving of high-priced protein foods by the use of a fairly high protein silage, and in my case the silage was grown largely on a very light sandy soil. The crude protein content of the 1947 silage was 15.02 per cent, with a fibre content of 32.24 per cent in the dry matter, and it is quite possible that one could obtain a better protein percentage on land with more body. However, at the moment, I feel that by using the lighter land to grow grass silage more use can be made of the grass than by grazing in the normal way.

Over a long time I have tried out different weights of silage per lamb per day, and with 1 lb. of crushed oats and ¼-½ lb. of good hay, I have found that 10-11½ lb. of silage will give a liveweight gain of 2-3 lb. per sheep per week.

As regards water requirements of sheep on grass silage, I think that when some hay and concentrates are fed water should be available, but so far as my own experience goes the quantity required is very small.

At this point it might be worth while to discuss the most suitable type of feeding container for silage, and it will be seen why stress is laid on short

grass and good quality. I have found the diamond-sparred hay-rack to be easily the most suitable, since protection from wet weather is essential; if silage gets wet and slimy, sheep will not eat it. Sheep prefer short grass silage, and while unchopped grass may be suitable if cut and ensiled when very young, I have found that more mature grass put through a cutter-blower also makes a very suitable feed for sheep. With a sparred rack, silage made of long grass is inclined to "arch" when the silage in the lower part of the rack has been eaten, and the upper layers have to be broken up.

Waste of material is another important consideration. Here again, short grass silage has the advantage, for when the sheep pull long silage out of the rack an appreciable amount inevitably falls to the ground and it is trampled underfoot. I have tried feeding grass silage out of ordinary open turnip boxes, but here also there is waste of material and the need to protect the silage against wet weather. I used to hope that once a sheep, say a ewe hogg, had eaten silage during her first winter, it would be easy to get her to eat it off the ground when carrying her first lambs during the following winter. With calving heifers no difficulty has been found in feeding silage in this way but, as I have said before, nothing but the best and cleanest will do for sheep. Once the feed is on the ground and trampled upon, they have no further use for it.

Changed Methods to meet Changed Conditions

In conclusion, there are several points which I would like to mention, as they have a considerable bearing on the final financial returns for fat sheep. One that comes to mind immediately is the exceptionally good health of all sheep I have fed on grass silage, and with lambs at £7-£8 each, this is a most important point. Secondly, the feeding of grass silage is economical of labour. Provided sufficient hay-racks, or other suitable type of container are used, weekend feeding entails little trouble; a tractor-trailer can be loaded on Saturday or even Friday, and then it is only a case of filling up the racks to last until Monday morning. A hay-rack holds 3½-4 cwt. of silage, and this works out at about 10-11 lb. per head for 40 lambs per day—a suitable number to allot to each rack.

There are still many knowledgeable flock-masters who have great faith in roots, along with good hay and concentrates, as being the ideal winter feed, but conditions today demand new methods, and to the man who feels that roots are too expensive a crop to feed to sheep, silage may well prove to be the feed which will enable him to make full use of that most valuable animal.

Principal Italian Agricultural Fairs, Italy, August-October, 1949

Italian Wine Exhibition
Mostra—mercato dei vini pregiati d'Italia .. .. Siene, August 8-18

National Fruit Exhibition
Mostra Nazionale Della Frutta.. Verona, first fortnight in August

Levant Fair—International Sample Fair
Fiera Del Levante—Campionaria Internazionale .. Bari, September 10-26

National Exhibition of Italian Cheeses
Mostra nazionale dei formaggi tipici italiani
Modena, September 24-October 3

Autumn Horse Fair
Fiera autunnale dei cavalli .. .. Verona, October 9-12

THE OUTWINTERING OF BEEF STORES ON GRASSLAND

G. PEARSON HUGHES, B.Sc.
Grassland Research Station, Stratford-on-Avon

IN the June, 1948, issue of this JOURNAL a method was described of conserving grass *in situ* from late summer growth and its utilization by cattle during the winter months(1). The points brought out in that article were that cocksfoot grown in drills 2 feet apart, and of a quality equal to the general run of hay in this country, could be carried into the winter period *in situ* and could be fed to cattle without unduly spoiling the herbage and without excessive poaching of the land. The cattle were given hay in addition to the foggage, and they maintained thriftiness and their body weight.

In view of the present serious scarcity of meat in this country, and the need for increasing home supplies, the further experience gained in the outwintering of beef stores on grass rows at the Grassland Research Station during the 1948-49 winter may be of practical importance to the grazier. In addition, the winter grazing of these grass rows has implications for herbage seed production, which will be briefly considered.

There is also evidence to show that the grass-row system of winter grazing is valuable for carrying store sheep as well as cattle. The present article deals only with its uses for cattle feeding on the assumption that, if beef cattle are to make any substantial and economical contribution to home meat supplies, much research remains to be done on the production of high quality beef from grassland. This question includes fattening on the pasture during the summer months, and indoor feeding on high quality silage and dried grass during the winter. The contention of Morrison and Heaney(2) that winter feeding on silage is a possible and profitable method of fattening bullocks is supported by the experience of indoor feeding at the Grassland Research Station.

A Way of Increasing Stores The production of prime beef from grass during the growing season necessitates overwintering of stores—of, say, eighteen months to two years old. The experiment discussed below deals directly with this problem. Possibly the method adopted is applicable only under lowland conditions in the southern parts of the country, where outwintering is not too rigorous. There are, however, lessons to be learned from the system that could be helpful for increasing supplies of stores from the rearing grounds of the North and West. More intensive systems of grassland management, coupled with the breeding of suitable hardy stores, could be introduced into the marginal areas of the farmlands of these islands. In this way greater use could be made of the potentialities of lands now lying idle. Store cattle are at present not only expensive but scarce. They could be raised fairly cheaply in the rearing districts if an appropriate system of grassland management could be evolved whereby the stock would feed on grass in the summer, and grass products (hay, silage, foggage, etc.) would provide high quality feed for the winter. Gregor *et al.*(3) have indicated the value of "complementary" grazing in providing part of the diet as protein-rich young grass, when a breeding flock of ewes and lambs is under hill conditions for the main growing period of the year. These workers, however, state that during the months of January, February and March, "complementary" grazing is impracticable. We, at this Station, believe that with the adoption of a suitable method of conserving grass *in situ* "complementary" grazing may be possible under hill land conditions during the dead months of winter. Herbage so conserved would be

of the utmost value during a normal winter period. It is with such systems of grazing that our stock-depleted hill lands can once again be made to play a major part in the provision of home meat supplies. In this manner adequate numbers of store sheep and cattle could be made available to the lowland grazier.

Under the soil and climatic conditions at this Station the aim has been to conserve herbage of the very highest possible quality for winter feeding *in situ*. The 14 acres of S.143 cocksfoot rows available for feeding in the winter of 1948-49 had been grazed with cattle during the summer of 1948. From July 19 the area was closed to grazing and a complete fertilizer dressing was given at 6 cwt. per acre, and additional nitrogen was applied at 3 cwt. per acre. The rows were cultivated fairly thoroughly. The field was then rested until it was grazed by cattle in January, 1949.

Time and Area Feeding Compared In contrast to the grazing management of the 1947-48 season[1], when free access was allowed to the cocksfoot rows at all times, two comparative systems of grazing management were adopted in the 1948-49 winter. The essence of both systems was to ration the feed available, and for this purpose full use was made of the electric fence as described for the folding of kale by Castle and Foot[4]. The equipment proved entirely satisfactory; it needed the minimum of attention and was easily moved to a fresh site as needed. The grazing area of approximately 14 acres was divided into two blocks A and B—of 6 and 8 acres respectively.

The 6 acres in Block A were grazed as one unit. The cattle were allowed to graze for six and a half hours daily from January 18 to February 12. From then until February 22 free access was allowed for the whole of the twenty-four hours. This we shall refer to as the "range" system of management.

The 8 acres in Block B were divided by electric fencing into twelve paddocks, each of two-thirds of an acre. When feeding the cattle on this area, access to a fresh plot of two-thirds of an acre was given every three or four days, according to the feed available. Rationing in this case was therefore by *area of feed available* instead of by *time*, as in Block A.

Observations were made comparing the two systems of utilization. Attention was paid to the effectiveness of utilization and the difference in intensity of poaching on the two areas. The "range" system of grazing (Block A) and that of Block B are illustrated on p. iv of the art inset.

A comprehensive system of herbage cuts was carried out in order to follow the changes in herbage quality during the period of conservation and utilization. Relevant figures are given in Table 1. Dates of the cuts made between January 18 and April 15 correspond to the dates of the changes in management. Additional cuts were taken before the cattle were brought on to the experimental area.

In the first winter of the trial under review (1947-48) hay was fed as a supplement [1]. For the 1948-49 winter better foggage was available. Samples cut on January 18, 1949, contained 10.53 per cent crude protein, and it was considered that no supplementary feed was necessary. The winter of 1948-49 was mild and the cattle were carried in reasonable condition without any supplementary feed. Little loss of body weight or thriftiness occurred.

Table 1 shows that the feed available during the latter part of October was of fairly high quality. It gave an analysis of 25.3 per cent "burn" and total crude protein content of 14.3 per cent. After this time, a gradual deterioration of feeding quality took place. The feed offered on January 18

Table 1. Quality of Herbage Offered

Date of Cut	Manage-ment	Dry Matter *Yield in lb. per acre*	Crude Protein *per cent*	Composition of Herbage Offered Expressed as Percentage		
				Leaf	Stem	"Burn"
20.10.48	Resting	Not available	14.3	62.8 (13.13)*	11.9 (4.98)	25.3 (4.62)
8.12.48	Resting	Not available	11.5	42.6 (13.95)	7.0 (3.34)	50.4 (4.88)
11.1.49	Resting	Not available	11.3	33.7 (15.72)	8.2 (9.07)	58.1 (5.94)
18.1.49	Range grazed	2,854	10.53	32.8	7.8	59.4
22.2.49	Close folded	2,589	8.46	23.5 (15.09)	6.9 (9.66)	69.6 (6.08)
29.3.49	Close folded	2,550	8.30	20.4 (15.87)	7.0 (9.79)	72.6 (6.43)

* The figures given in brackets are the crude protein percentages of the various separates.

contained 59.4 per cent "burn" when the cattle were turned in. Towards the end of the trial period, on March 29, the "burn" had risen to a peak of 72.6 per cent. The crude protein figure on January 18 was 10.53 per cent; by March 29 it had fallen to 8.30 per cent. The percentage of protein in the green leaf, 15.87, was still high even in late March. "Leaf" contributed at this latter date still 20.4 per cent of the total herbage. The trial is not directly concerned with loss of quality at this time of year, but it should be noted that in order to get the full grazing value from cocksfoot conserved *in situ*, the herbage should be fed off by late December. Grazing to the end of the year only would allow a seed crop to be taken from the rows in the following summer without serious depletion in yield (8). Evidence is also accumulating to the effect that a follow-on of nutritious grazing in January to March can be better obtained from rows of leafy timothy and leafy meadow fescue conserved *in situ*. With these latter grasses the herbage is less likely to deteriorate as the winter progresses. Here again, it may be possible to take seed crops in the following summer as well as to graze in winter.

Midwinter Liveweight Gain The stocking of the area in the winter of 1948-49 was done with 1¾- to 2¼-year-old cross-bred Hereford steers. Seventeen cattle were turned in to the 6 acres of Block A on January 18 and were allowed "range" grazing on a restricted time basis until February 12, when they were allowed free access at all times until February 22. At this date they were folded on plots in Block B and remained there on an "area" rationing system until the completion of the trial on April 5. Relevant figures for live weight are given in Table 2, the animals being in a fasted condition at each weighing.

Table 2. Average Fasted Weights of Bullocks

Date	*lb.*
January 18	1,158
February 12	1,198
February 22	1,188
March 11	1,185
April 5	1,140

When turned in on January 18, the cattle weights ranged between 924 lb. for the lightest beast to 1,365 lb. for the heaviest. At the end of the period of grazing, on April 5, this variation was between 878 lb. for the lightest and 1,392 lb. for the heaviest. The individual weights recorded support the view that with the quality of feed available, the more forward animal is best able to maintain condition. With improvement in cultural techniques and the production of higher quality feed, both younger and older cattle should maintain body weight without loss. Table 2 shows, on average, the loss of body weight between January 18 and April 5 on a feed supplied by cocksfoot grass rows alone to be only about 18 lb. per beast, and that until the last weighing, when keep was almost used up, body weight was on the average higher than when the cattle were first turned in.

The implications of these data are interesting and of major importance to us as a nation. It will be noted that for the first period of 25 days, i.e., from January 18 to February 12 (see Table 2) the seventeen beasts gained on an average 40 lb.—a liveweight gain at midwinter of 1.6 lb. per day. Such a gain would not be despised even at the height of a normal summer.

It is important to realize that this system of winter grazing of grass rows opens up a number of possibilities. First, it provides a cheap method of feeding store cattle during the winter. The data discussed show that for a period of eleven weeks during the non-growing season an area of 14 acres maintained seventeen head of mature cattle without supplementary feed and with insignificant loss of body weight. If such a method of winter utilization could be coupled with efficient utilization at other times of the year, it would have practical possibilities. Winter utilization of grass in rows must therefore, in some way, be coupled with summer utilization. Three methods of approach are suggested: (1) taking a grass seed crop in the summer following winter grazing; (2) providing summer grazing during the dry July-August period in the low rainfall areas; or (3) combining (1) and (2) in alternate years, but providing maximum winter grazing of high quality for every year.

References

1. Hughes, G. Pearson. The Utilization of Foggage. *Agriculture* (1948), **55**, 98.

2. Morrison, J. and Heaney, I. H. Grass Silage for Winter Fattening of Bullocks. *Agriculture* (1949), **56**, 71.

3. Gregor, J. W., Watson, P. J. and Connell, W. D. Cultivated Grass in Mountainous Districts. *Scottish Agriculture* (1949), **28**, 4, 189.

4. Castle, M. E. and Foot, A. S. Close Folding of Dairy Cattle with the Electric Fence. *Agriculture* (1949), **56**, 1.

5. Evans, T. A. Grassland Research Station, Unpublished data.

BRACKEN POISONING

H. E. WELLS, B.Sc., N.D.A.
County Agricultural Officer, Staffordshire

BRACKEN is one of the many plants reported on occasion to cause illness or even death in grazing cattle. That it is not a very common cause of trouble is evident from the impunity with which cattle graze on bracken-infested land in most hill districts, parks and so forth. In 1948, however, in some of the West Midland counties a number of cases in which bracken appeared to have caused the death of cattle were reported. A case of particular interest, in which most of the attendant circumstances were known and recorded, occurred in Bagots Park, Abbots Bromley.

Bagots Park is a block of primeval forest land extending to about 700 acres. Before the war it carried a poor turf dotted with ancient, picturesque oaks and large sweeps of dense, tall-growing bracken. Rushes were plentiful in places but for a boulder clay the soil could not be described as wet. It was grazed by semi-wild deer and goats ; and for as far back as living memory goes, ley stock had been taken in for grazing during the summer months. Though the herbage was admittedly of low quality, the Park had a reputation as sound rearing land ; there is no record or tradition in the district of trouble in stock from bracken. Part of it was used as a bombing range by the R.A.F. during the war. By arrangement with the owner, Lord Bagot, the Park was taken over by the Staffordshire W.A.E.C. late in the war. During 1945 and the succeeding three years a total area of about 400 acres was ploughed out and reseeded on the upturned sod, the bulk of the work being done in 1945 and 1946.

Reclamation The general practice in reclaiming the bracken-infested areas was to destroy the frond by disc harrowing when it had reached its maximum growth in July, plough in September, apply 4 tons of ground limestone dust per acre before Christmas, and cultivate and sow down as soon as the land was dry enough in the following spring. The seedbed was prepared with furrow press roll and heavy disc harrows drawn in tandem. Seeds and fertilizers were sown together, half being sown in one direction and the other half diagonally across the first drilling. The fertilizer consisted of ammonium phosphate or its equivalent, at the rate of 2 cwt. per acre. The following mixtures were sown (*lb. per acre*) :

		1945		1946
Italian ryegrass	...	7		
Perennial ryegrass	Mixed	18	Mixed	12
Cocksfoot	,,	5	S.143	8
Timothy	...	3		—
Alsike	...	3	S.100—1 lb.	2
White clover	S.100	1½	N.Z. wild	¾
White clover	Wild	½	English	¼

Very little bracken appeared amongst the young seeds. There were, however, small areas where the destruction of the bracken frond was not done in July or early August ; such land was ploughed in the autumn as a first operation. In these places stunted growth of bracken did appear in the new leys.

Approximately eighteen months after seeding down, the leys received a 15-cwt. dressing of ground limestone per acre and 3 cwt. superphosphate per acre. In February, 1948, the area seeded down in 1945 and 1946 received 1½ cwt. per acre of nitrogen.

Stocking The Park was heavily stocked with agisted yearlings and two-year-old heifers during each grazing season from the beginning of May to mid-October. To facilitate control of grazing, it was divided into

three approximately equal plots by wire fences. Each plot contained both reseeded and untreated land, and bracken areas occurred in each. The stock were moved from plot to plot at short intervals, according to the amount of keep available, the tendency being to move more frequently during the early growing season than later on, in order to check the grass running to flower. The numbers grazed were as follows :

1945	1946	1947	1948
340	533	691	741

Naturally, with agisted stock of this kind, derived from fifty or more farms, there were a few casualties and withdrawals each year, but in the first three seasons nothing in the nature of an epidemic occurred.

In 1948, however, following a few individual cases of ailing animals in July, a considerable number of animals began to show signs of intestinal trouble, later diagnosed as symptoms of bracken poisoning.

Symptoms of Poisoning The affected animals showed a characteristic dullness, stood with their backs up, grinding their teeth, had a staring appearance and a disinclination to move or eat. There was a watery discharge from the mouth and nose, followed by bleeding from the nose, particularly if the animal was excited. The fæces were dark and loose and frequently tinged with blood. In advanced cases large clots of blood were passed ; in some the pupil of the eye filled with blood. There were several cases of a sub-acute type in which animals showing characteristic symptoms recovered within a few days when moved on to fresh pastures.

Early in September, 1948, N. H. Brooksbank, of the Veterinary Investigation Department, Tettenhall, was called in. On the evidence of symptoms and post-mortem he diagnosed bracken poisoning. Examination showed that in all parts of the Park cattle had waded into the standing unploughed bracken and browsed upon it. Here and there areas of over an acre had been bitten down to half the normal height. Evidently considerable quantities had been eaten.

As soon as the nature of the trouble was realized, owners of cattle were given the option of breaking their grazing contract and removing their stock. A large proportion of the cattle were taken out of the Park for the remainder of the season ; in most cases details of their subsequent history were obtained from the owners. In all, the following casualties were sustained :

Died in Park	9
Died after removal	11
Affected but recovered (approx.) ...	7

The Underlying Cause The circumstances of this outbreak point clearly to seasonal effects. The year 1948 was extremely good for grass. Even a stock of 700 head could not keep down the grass on 400 acres of reclaimed land. In August it was lush and rank. Apparently under such circumstances cattle develop a craving for fibrous material, which they satisfy with bracken if nothing else is available. Clearly it would be wise, in areas of this kind, to have available straw or hay which could be put down as an alternative form of roughage. But it is easy to be wise after the event.

THE CONTROL OF DISEASES OF LIVESTOCK

T. Dalling, M.A.
Chief Veterinary Officer, Ministry of Agriculture and Fisheries

THE important place occupied by livestock in agriculture cannot be overrated: a prosperous agriculture depends in considerable measure upon a healthy livestock population. This, in turn, is greatly influenced by the knowledge of the causes which give rise to the various diseases and by the methods adopted for their control. After many years during which research on these subjects was left to a few pioneers, who carried out excellent work with the limited means at their disposal, research and investigational work on health and disease problems is now being encouraged: this has resulted in a marked step forward, and measures of control for some of the economically important diseases of livestock have proved to be of great value to the farming industry.

Great Britain is in a favourable position concerning the epidemic diseases found in other parts of the world, which, on occasion, sweep through countries and even continents, leaving disaster in their wake. That dreaded disease cattle plague, or rinderpest, has been absent from this country for many years. Our position of relative security is due partly to our insular situation, partly to the foresight of our predecessors who influenced the governments of their day to bring legislative measures into operation, and partly to the exercise of close attention and care in dealing with anv suspected exotic disease which may make its appearance. Periodical outbreaks of foot-and-mouth disease occur, but, generally speaking, they are promptly suppressed. Swine fever is usually present in the country but is well under control. Fowl pest (Newcastle disease) was introduced into Great Britain in 1947 and spread to many parts: by the application of suitable control measures the incidence of the disease has been considerably lowered Constant vigilance, however, is necessary so that the first appearance of any unusual disease is recognized. The appropriate means for its suppression can then be put into operation without delay.

There exist many other diseases of economic importance, some of which can now be controlled efficiently. It may be that some of the methods of control practised at the present time are but palliatives and that better means will eventually be found. As our knowledge of fundamental processes extends, our ideas on health and disease control will certainly alter: until, however, much more research work of a basic type can be done, we shall continue to seek and apply methods of control similar to those now in operation.

Dairy Cattle The dairy cow is one of our most valuable animals and her produce is extremely important There is a constant demand for more milk, and any factor which will lead to a further increase in our milk supply is, therefore, important. Diseases of the dairy cow are now better understood and can be controlled Bovine tuberculosis, which is a serious disease not only from the animal but also from the human health point of view, is well under control in some areas. The encouragement given to dairy farmers to have their herds freed from tuberculosis has shown how readily those interested respond and how, within limits, it is comparatively easy to control that disease. The introduction of more reliable and potent tuberculins, the change in the method of their application and the knowledge of the interpretation of the results of tuberculin testing have completely altered our views on the eradication of bovine tuberculosis. There is, of course, a long way to go before the country will be free from this disease: there are some very "black" areas, but there is little doubt that, in time, the

disease will be eradicated completely. Bovine mastitis can now be well controlled, especially when it occurs in certain forms which have been the subject of much research.

The association of micro-organisms with mastitis is now well recognized, and control centres on their elimination from the udder, together with the adoption of measures to prevent further infection of the udder. The knowledge of the infection process has assisted considerably in devising control measures, and the valuable work of chemists in producing new chemo-therapeutical substances and antibiotics has been of the greatest help in the study of the control of mastitis. Some forms of bovine mastitis are still imperfectly understood, and further intensive study is necessary before reliable control measures can be worked out.

Brucellosis (contagious abortion) should, in the future, cause less trouble than hitherto, and losses from its presence in a herd should be completely eliminated. The setting up of resistance to the infection by the use of the newer forms of vaccine is the control method of choice. The now world-famous Strain 19 vaccine is proving its value in many countries It must be pointed out, however, that resistance or immunity is relative to the amount and virulence of the infecting agent ; very likely complete immunity against infection in all its degrees is impossible. The use of this vaccine is, however, reducing the incidence of brucellosis to a marked degree, and the results of its application are being reflected in many herds. We still have much to learn about Johne's disease : although the causal micro-organism is known the way in which it acts is not fully understood. Research work is progressing, but it will be some considerable time before we are in a position to advise fully on methods of control.

One of the important and difficult subjects of investigation is infertility in cattle. There is a great deal of evidence that infertility, largely temporary in character, is now more prevalent than in past years Some forms are associated with the presence of micro-organisms in the reproductive organs : as a rule it is comparatively easy to deal with the disease in this form and restore the animal or the herd to normal breeding. Difficulties arise, however, in dealing with other forms of infertility, and much research work is necessary before we shall be able to understand the complex relationship of hormones, nutrition, and other factors to reproduction in the dairy cow. The recent discovery of the presence of oestrogenic substance in certain grasses under different conditions of growth is of major importance.

Sheep Our knowledge of diseases affecting sheep has increased in recent years. We understand the causation of that large group of diseases known as entero-toxaemias, in which micro-organisms of the anaerobic group (to which sheep are so highly susceptible) produce poisons or toxins in the digestive tract and so cause heavy losses. We may not yet appreciate the exact reasons why these micro-organisms suddenly become active, but methods of setting up a resistance or immunity to the toxins have been elaborated and are now in common use.

Parasitism in sheep has been the subject of much study. External parasites—ticks which convey diseases like louping-ill, tick-borne fever and pyaemia ; the sheep maggot fly which causes extensive damage in some areas ; and the highly infectious sheep scab mite—can now be well controlled by adequate dipping with the recently introduced chemical agents, DDT and benzene hexachloride. Internal parasites can be controlled both by the adoption of suitable methods of husbandry and by the regular use of reliable anthelmintic agents, of which phenothiazine is probably the best now in use.

The study of the effects upon health of deficiencies of some of the minor or trace elements in the diet has been largely made in sheep. Cobalt deficiency is now well understood, and the addition of traces of that element to the diet, either by direct dosing, mixing with the concentrates or through the pasture by suitable manuring, controls to a marked extent the disease called "pine" in its various forms of intensity. The relationship of mineral deficiencies to the incidence of internal parasitism is also appreciated. The various trace elements are being studied one by one, and as time goes on much more knowledge of their importance will be gained.

There are diseases of sheep, of course, which are still very imperfectly understood: diseases associated with faulty metabolism are well recognized, for example, but we have still to appreciate why they arise and how they can be prevented.

Pigs and Poultry Diseases of pigs have also been the subject of much research work. Swine fever has been controlled by the legislative measures in force for the time being. Crystal violet swine fever vaccine—a recent introduction—has proved itself by large-scale experiments to be a safe measure of preventing the disease and conferring immunity for at least a year after injection. It must be remembered, of course, that this vaccine is valuable only in herds which are free from infection when it is used, and that it is not a curative agent, but merely acts as a preventive against the disease

We still have much to learn about the relation of nutrition to disease in pigs. Some facts are well known—for example, the need for young pigs to have access to iron—but the various disturbances which occur in the digestive tract, associated with nutrition, have still to be worked out more fully. The condition referred to as "oedema of the bowel" is an example of a condition in pigs which requires much investigation.

Diseases of poultry are also much better understood nowadays, with the result that as the industry increases and regains its previous important position in agriculture, poultry farmers can adopt measures whereby much of the severe loss experienced after the first world war should not recur.

These few examples illustrate the progress that has been made in the fight against animal diseases: but research work must continue on an ever-increasing scale so that the losses from diseases in livestock can be minimized and the conditions under which health can be well maintained are more fully appreciated.

THE LIGHT TRACTOR AND THE SMALL FARM

R. R. W. FOLLEY, B.Sc.(Hons.), B. Comm.
Agricultural Economics Research Institute, University of Oxford

GREATER output is the economic order of the day. Large and medium-sized farms have increased their output by mechanization. To a less extent many smaller farms which do not come within the size category for which the standard tractor was designed have done the same. For most farmers who occupy less than 75 acres the provision and upkeep of a standard tractor costing, in round figures, £300, is an unwarranted expense. By working this machine at each job for only a short time and hitching it to implements not built for tractor towage, its full power cannot be utilized.

Small farms, which have a particular need of high output per acre, have been faced with severe problems of readjustment and have had to rely upon a variety of aids towards a policy of greater self-sufficiency. Their output, however, seems not to have increased as much in proportion to capital and labour employed as it has on the larger farms, and for the last two or three years the cost of labour has been a heavy charge on the business. The merging of holdings has been suggested; it could well be associated with mechanization. A relatively cheap and adaptable source of mechanical power should help in reaching a more favourable ratio of output to cost on these farms.

It is not possible to differentiate in general between the circumstances where the remedy would be to reduce costs more than output and those in which the remedy would be to increase output whilst not increasing costs proportionately. In practice the decision as to the course to take is probably connected with the replacement of a standard tractor by a light tractor in the first case, and with changing over from horses to the light tractor in the second. An attempt is made later in this article to assess the economy of the light tractor in each instance.

The lighter and cheaper machines available today cannot readily be substituted for either tractor or horses on small farms. They have been designed primarily for tillage operations; their two-wheeled chassis gives a high efficiency in this use, and justifiably they have become popular for horticultural work. On the small farm something more is required from them. Harvesting, haulage and barn work may account for one-third of all tractor-hours on the mixed farm, and even more on a stock farm. The advantage in output per unit of both time and cost which the machine offers in tillage and barn work does not apply to harvesting and hauling. Speed over the ground (2½ m.p.h.) is slow, and the weight of load which they will comfortably haul (15 cwt.) does not compensate adequately.

It is the relation between the total of tillage work and the importance of the winter stock-food harvest which will decide whether any general benefit would follow the introduction of the light horticultural type of tractor on the small farm. A machine better adapted for draw-bar work, having a higher and more flexible effective haulage rate, backed by good servicing facilities and yet combining the versatility and low cost of two-wheeled tractors, would be much more useful. This is the type of light tractor—and several models are now being developed—whose performance is now considered. Reliance on contract work for the heavier jobs would still be necessary, but the machine would be closer to the scale of the existing labour force and operating equipment on small farms. As a general principle, the intensive arable farm stands to gain more from mechanization than the intensive stock farm; though there is no denying that a variety of uses has been found for small machines on all sorts and conditions of farms.

A guide to the cost of operating the ordinary two-wheeled light tractors is given in the accompanying Table. It relates to a 3½ h.p. machine worked for the two years 1946 and 1947. Drilling and cutting of grain crops were done by contractor. It is seen that the tractor worked 900 hours. Set beside the recorded figures, however, are estimated costs for an assumed full utilization of 1,400 hours a year.

Hourly Cost of Working a Light Tractor

	As Recorded, for 900-hour Utilization			Comparative Cost Estimated for 1,400-hour Utilization	
	£ s. d.	£ s. d.	per cent	£ s. d.	£ s. d.
Running Costs					
Petrol, 190 gal. at 2s. 1½d. per gal.	20 3 9		33.2	31 7 2	
Oil, 24 gal. at 8s. per gal.	9 12 0		15.8	14 8 0	
Repairs (materials and labour)	2 12 6		4.3	4 0 6	
Daily attention (labour at 2s. per hr.)	2 0 0	34 8 3	3.2	3 0 0	52 15 8
Overhead Expenses					
Road Fund licence and insurance	1 0 0		1.6	1 0 0	
Routine attention and maintenance	3 10 0		5.8	3 10 0	
Depreciation	22 0 0	26 10 0	36.1	27 0 0	31 10 0
Total Cost per Annum ..		£60 18 3	100.0		£84 5 8
Cost per Hour		16.24d.			14.45d.

(Petrol consumption has been charged at the rate of 1.7 gallons per day of eight hours, oil consumption at 0.8 pints, on account of the drip-feed to chains, with a change of oil after every 50 hours' running. Five minutes a working day has been allowed for greasing and attention. Routine maintenance includes decarbonizing at six-monthly intervals. Depreciation has been calculated proportionately to working time over two years on a reducing instalment system of 22½ per cent per annum.)

From a knowledge of working costs and work performance it is possible to estimate the relative economy of the light tractor against both standard tractor and horses. In comparison with the standard tractor, the cost of working a light tractor is high for a given amount of work. Taking the machine alone, the work done per unit of cost is 15-20 per cent less, and when the cost of an adult driver's time is added that figure falls to 40 per cent. Only if the standard machine and its driver were idle for two-fifths of their normal working year—a most unusual eventuality—would the light tractor begin to compete. Assuming the average case that the two-wheeled machine can do three-eighths of all the work of the larger machine in the same time, there would be no saving in the cost of tractor labour until the tractor-man unit was being used productively for only 300 hours a year. In terms of farming systems this means that the size at which a light tractor could economically replace the larger machine would be about 60 acres for grass farms with 70 per cent of permanent grass, 40 acres on mixed farms with 50 per cent of permanent grass, and 30 acres on arable farms with 25 per cent of permanent grass.

When the figures are compared with recently published costs of horse labour*, it will be seen that the annual cost of a two-wheeled tractor working about 900 hours a year is at present a little more than that of keeping one horse. The slightly faster rate of working, depending upon the operator, is a factor to be taken into account, and for management purposes it can be said that a job which takes a horse team ten hours can be done by the machine in eight. The real advantage in the field is greater than this, for cutting down stable work means further saving. Thus, if the tractor were to replace a two-horse team working 1,200 hours throughout the year, there would be a direct saving of 40 per cent in cost of motive power as well as a saving of 240 man-hours. If the machine were to take the place of only one horse throughout the year and still get through 20 per cent more work in the same time, the extra cost of the tractor would be saved in labour. Even if the tractor did the work of horses at the same rate as horses, the light tractor would be economic whilst working 900 hours a year, so long as it could be kept on two-horse work for 60 per cent of its working time. Where the machine could be worked for 1,400 hours a year, there would be a potential increase of 2½ times the work output per man, compared with that given by one horse, for a one-third increase in the cost of farm power.

Complete assessment of the position is hampered by the great difference between the horse-power supplied by tractors and their effective rate of substitution for horses. Although it is said that the tractor can do the work of six horses, in practice only three are replaced. Should the situation arise that 1,200 horse-hours on the 40-acre mixed farm were replaced by 800 light-tractor hours instead of by 400, any benefit from mechanization would be confined to a shorter working year. Assuming an advantage of one-fifth over a two-horse team, and that one-third of all tractor hours are taken up by non-tillage work, a mixed farm of 60 acres could, with ideal organization, be handled with a light tractor of the type envisaged. The figure of 40 acres given previously is a measure of the wastage where tractors are not used to capacity and of the increased demands upon motive power made necessary by the farming self-sufficiency campaign.

Thus so long as high farming is the rule there is likely to be only limited scope for employing the light tractor in place of the standard machine, because opportunities for profitable employment of the time saved by the latter can usually be found. The same considerations foreshadow an extension of mechanization to smaller farms at present relying upon horses and contractors. Due regard must be paid to the latent dangers of over-capitalization in pressing the new machine into use on a farm which is too small to provide enough work for it, or where marginality in any factor makes increased output too expensive. But when performance can be balanced with cost in a light tractor, gains in productivity and savings in labour on small farms can be considerable, particularly where a farmer is single-handed or where tillage and the "cropping" of grassland have been superimposed on predominantly livestock farms.

* Compare average cost per horse-year, £59 13s. 7d., and per horse-hour, 10d. (1940-47), A. J. Marval, Horse Labour Costs at the Lord Wandsworth College, 1937-47, *Agriculture* (February, 1948) or £53 8s. 10d. and 10.22d. (1944-45), J. Wyllie, The Cost of Horse Labour and Tractor Work, *Wye College, Department of Economics, Report No.* 38 (1946).

THE EFFECT OF TEAT-CUP ASSEMBLY WEIGHT ON RATE OF MACHINE MILKING

F. H. DODD, B.Sc. (AGRIC.) and ETTIE HENRIQUES, B.Sc. (AGRIC.)
National Institute for Research in Dairying, Shinfield

Earlier articles relating to this subject have appeared in this JOURNAL in March, 1947—"Efficient Milking," and September, 1948—"Residual Milk"

ALL milking machine operators who have attempted to adopt quicker methods have been hampered by the very slow milking cow. Dodd and Foot [1] have pointed out that cows show marked individuality in their rates of milking and that it is very difficult to speed up the rate by changes in management. A common method is to increase the weight of the teat-cup assembly by lodging weights or bricks between the short milk tubes. The following short-term experiment was designed to discover the effect of this practice on milking rate and yield.

The experiment was carried out with six cows giving from 2½ to 5 gallons of milk per day and varying in the total duration of morning milking from 5½ to 11 minutes. The milking machine used was of a standard bucket type, fitted with moulded teat-cup liners and operated at a negative pressure of 14 inches of mercury and a pulsation rate of 42 per minute. The teat-cup assembly in normal milking position weighed approximately 7 lb.

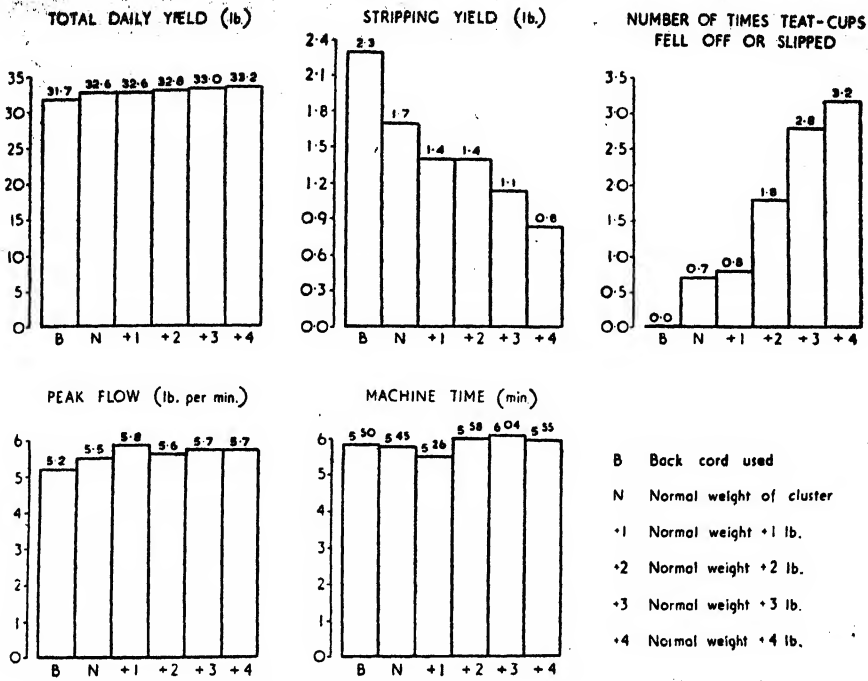
Six Weights Compared Six different weights of teat-cup assembly were compared. These treatments were randomized, so that every cow had each treatment once in a six-day period and no two cows had the same treatment on one day. The weight of the teat-cup assembly was altered by supporting it with a back cord in one treatment and by adding weights up to 8 lb. in other treatments; 6 or 8 lb. added to the normal weight of the assembly was found to cause a good deal of irritation, and the teat-cup fell off so frequently that the treatment had to be abandoned. For the next four periods the weights were:

Normal teat-cup assembly with support
,, ,, ,, without support
Teat-cup assembly + 1 lb
,, ,, + 2 lb
,, ,, + 3 lb
,, ,, + 4 lb

The amount of milk produced was recorded daily, and the milking rates were obtained by suspending the milking machine on a spring balance and taking readings at 30-second intervals, as described by Foot [2]. Machine stripping began when the rate of milk flow fell below 0.4 lb. per minute, and the milker removed the teat-cup when he considered that milk had ceased to flow. The number of times that the teat-cups fell off or had to be prevented from falling off was recorded at each morning milking.

The effect of the treatment on milk yield and milking rate is shown on p. 213. Total daily yield shows an insignificant increase with each weight increment. The effect on yield of machine strippings, however, is very marked and statistically significant ($p=0.01$): the addition of the 4-lb. weight reduced the strippings to one quarter of those obtained when the back cord was used, probably because the weights prevented the teat-cups from crawling up the teats and stopping the free flow of milk through the teat sinus[3]. Unfortunately, this advantage is obtained at the expense of an increase in the number of times the teat-cups slip or fall off during milking. The cows differ markedly in their ability to carry the weighted teat-cups: one cow milked successfully with an additional weight of 4 lb.; two others needed occasional adjustment to the teat-cups when the 1lb. weight was added.

EFFECT OF TEAT-CUP ASSEMBLY WEIGHT ON MILKING RATE



The effect on rate of milking was slight. The "peak flow," or milking rate in the minute of fastest milking, was little affected. The normal teat-cup assembly was found to give a slightly increased peak flow, compared with the results when the back cord was used, and the addition of a 1-lb. weight gave a further slight increase. Though these increases were reflected in a small reduction in the machine time (i.e., the duration of milking up to the start of machine stripping), these changes are minor compared with the very great differences between the individual cows in peak flow and milking time.

From this small experiment certain practical lessons can be drawn. Cows which milk slowly throughout the whole process and leave very little milk to be removed by hand or machine stripping will show almost no improvement if additional weights are added. Cows whose udder and teat construction is such that the teat-cups readily crawl up the teats and prevent the removal of large quantities of milk without prolonged hand or machine stripping will milk more completely and efficiently if weights are used. This is practical, however, only if the cow's teats are such that the teat-cups hold quite firmly and if the cow is not irritated by the weights. It is also clear that the back cord should be used only when absolutely essential. This work confirms the observations of Maddever and Egdell ([4]), who found that in herds where back cords were used the total duration of milking was high.

This experiment suggests that for most cows the 7-lb. weight of the teat-cup assembly used is quite sufficient to ensure that machine or hand strippings are kept at a low level—a deduction confirmed by an analysis of the routine speed of milking records taken in the Reading Institute herd. This analysis shows that for 100 unselected cows milked with a normal assembly, the average amount of machine strippings is under 1½ lb. at each milking.

It should, however, be pointed out that these results apply to one particular design of teat-cup liner, and though changes in shape of liner are,

not likely to produce major changes in milking rate they may markedly affect the amount of machine strippings and the frequency with which the teat-cups fall off the cow.

References

1. DODD, F. H. and FOOT, A. S. *J. Dairy Res.* (1947) **15**, 1.
2. FOOT, A. S. *J. Dairy Res.* (1936) **6**, 313.
3. PETERSEN, W. E. *J. Dairy Sci.* (1943) **26**, 752.
4. MADDEVER, K. D. and EGDELL, J. W. *Agriculture* (1949) **55**, 436.

THE FENLANDS

F. HANLEY, M.A.
School of Agriculture, Cambridge

(A Paper read to N.A.A.S. and A.L.S. officers in the Eastern Province, July 1, 1949)

THE Fens cover approximately 800,000 acres of land around the Wash, stretching from the southern and eastern parts of Lindsey in the north, almost to the town of Cambridge in the south, covering a long, rather narrow stretch of land varying from 15 to 35 miles in width and some 70 to 100 miles in length. Most of the area lies within a few feet of sea-level, much of the black fen being at or below sea-level. It includes some of the most fertile farm land in this country, but its continued productivity is obviously dependent on an efficient system of artificial drainage.

The Fens were originally an estuary of which only the Wash now remains. The area is a shallow basin filled on the seaward side with silts and clays laid down in brackish water and on the landward side with peat formed under fresh-water conditions. In many places there is evidence of alternating marine and fresh-water conditions giving rise to alternate layers of silt and peat. The waterlogging was produced in part by the discharge into the area of numerous large river systems draining the uplands on the west and south of the area, and the fact that much of this water came from calcareous formations largely prevented the development of the acid type of peat one might otherwise have expected.

The floor of the basin was a relatively flat strip of Jurassic clay covered in places by other clays, such as Boulder clay, and, until conditions became favourable for peat formation, the area carried forests of oak and other trees (pine, alder and willow) rooted in the clay. The trees were first killed by waterlogging and submergence and then preserved by the accumulating peat, a condition in which many have remained until dug up in the course of drainage and reclamation work some five thousand years later. Large stretches of water, or meres, were formed in many parts of the fenland, e.g., Soham, Ramsey and Whittlesey, and these remained long after the early attempts at drainage, the last of them being artificially drained about a century ago.

The clay floor of the basin was not entirely level and hence islands of Jurassic clay, sometimes capped with Boulder clay or gravel, even now stand up above the peat deposits, e.g., Ely and Littleport.

The southern end of the Fens was farthest from marine influences, and here the deposits are chiefly peat, brown or black in colour and formed from decayed fresh-water plants such as sedge and Phragmites. To the north of the area, where marine conditions were prevalent, tides brought in considerable quantities of mineral material and the deposits are chiefly silt. In all, the silt deposits cover about 450,000 acres and the so-called black fen about 350,000 acres, chiefly at the southern end of the area, but with a narrow strip running up the west side and occasional pockets in other parts of the area.

The Fens were inhabited in pre-Roman times and no doubt there was some attempt at artificial drainage both then and during the Roman occupation, but the most important phase of drainage activity began in the seventeenth century, and from that time date most of the big straight drainage cuts or channels such as the Bedford Levels. Though the main scheme of drainage may be said to have been completed by the middle of the nineteenth century, maintenance and improvement have called for continuous effort since, and many difficult problems have developed.

Aeration and cultivation, following improved drainage, have led to shrinkage and wastage of the peat, and this in turn has produced a new problem in drainage. It has been estimated that two hundred years of drainage have lowered the peat surface by some 10 feet, and in some places the level of the fen peats before drainage was as much as 16 feet higher than at present. The lowering of the land surface is illustrated by the fact that the beds of former rivers diverted from their natural course many years ago now appear as silt ridges or "roddons" well above the level of the surrounding peat surface.

The figure usually given for wastage in cultivated fen is approximately ½-1 inch per annum, but the rate is much higher than this in the first few years after reclamation (4.75 inches per annum in the first twelve years in Denton Fen (Holme Post)).

As the level of the land surface falls, embankment of the rivers becomes more difficult and costly, and water has to be "lifted" a greater height from field drains to river.

Farming on the Black Fen Soils derived from silt deposits have very different agricultural characteristics from those derived from peat. The silts are a fine alluvial deposit varying in texture, but all are generally good agricultural land with deep soils resistant to drought. The main crops are potatoes, wheat and sugar beet, but considerable acreages of special crops have been grown in recent years, particularly peas (for canning and processing), brassicas of various types, bulbs and so on, as well as considerable acreages of fruit, especially round Wisbech.

The black peats which lie chiefly in the Isle of Ely, West Norfolk, West Suffolk, North Cambridgeshire, East Huntingdonshire, Soke of Peterborough, South-west Holland, Parts of Lindsey and East Kesteven consist of an accumulation of organic matter of varying depth overlying various types of mineral deposits. It is with these peat areas that this article is chiefly concerned, and here it is necessary to emphasize the marked variations from place to place, both in the depth and character of the alluvial deposit as well as in the type of underlying mineral material.

In the so-called black fen area there are frequent patches of what is known as "white fen," i.e., peat containing a high percentage of shell material; gravel fen, i.e., peat overlying gravel, and where the gravel is near the surface the surface soil may be a mixture of peat and gravel; and sandy fen, i.e., peat overlying sand and often mixed with considerable quantities of sand.

In other districts the surface peat may be relatively shallow and mixed with clay particles from an underlying clay formation. Where the peat is relatively shallow and mixed with mineral particles from the underlying mineral formation, the land is generally described as "skirt fen". Not only will admixture with mineral particles affect the agricultural characteristics of the peat, but the depth of peat and the nature of the underlying mineral material also have a profound effect.

It is common practice to speak of black fen as if the term denotes a single relatively uniform soil type, but this is not the case. The soil of the fen area varies widely from place to place, and the variation may be very sharp, a single field containing several very different soil types, though there are, of course, considerable stretches of good black fen of relatively uniform type.

To a large extent farming on the black fen is influenced by the free-working nature of the soil, its relative richness in reserves of nitrogen and relative freedom from drought due to the maintenance of a fairly high water-table. It is eminently suited to the production of potatoes and root crops generally. It is often said that few fen farmers farm on any set rotation of crops, and up to a point this is true for individual fields, but even on farms with no set formal crop rotation, the proportion of the farm-acreage under each crop is much the same as on farms where a strict rotation is followed. Opportunism is largely a matter of field policy rather than farm policy in this respect.

Broadly speaking, fen peat farmers follow either a three- or four-course rotation so that anything from one-half to two-thirds of the arable land is under root and vegetable crops with from one-third to one-half under cereals and usually only very little temporary or permanent grassland. The three-course rotation is: potatoes—sugar beet, mangolds or market-garden crops —cereals.

The exact order in which these three types of crop are taken may vary between farms. There is more time to sow winter corn after potatoes than after beet, but winter wheat can be sown later on fen than adjoining highland soils. Also, sugar beet gives a better chance to kill self-set potatoes than does corn, unless some spray treatment can be used. Self-sets help to perpetuate potato root eelworm and their haulm is a nuisance in a cereal crop at harvest time. In an attempt to widen the rotation and reduce the frequency with which sugar beet and potatoes are taken, on some land an additional cereal crop may be introduced between potatoes and sugar beet giving: potatoes, cereal—sugar beet or market-garden crop—cereal. This rather greater proportion of cereal crop is perhaps more characteristic of the skirt land than the true black fen.

In the black fen, potatoes are chiefly second early and maincrop. The area is subject to late frosts and therefore unsuited to first earlies.

The chief cereal crop is wheat, generally about two-thirds of the total cereal acreage, and though it is less subject to lodging than oats or barley, large areas are often "laid" at harvest. Attempts may be made to control a crop that is too forward in the spring by severe harrowing, grazing with sheep or cattle in late April or early May if dry enough, or by spraying with sulphuric acid to check the crop as well as control weeds.

Barley is not only more liable to lodging than wheat but conditions inevitably lead to the production of a coarse sample with a high nitrogen content, generally unsuitable for malting. In general, cereals are not popular crops with the fenland farmer. Yields of grain on fen peats are not high by comparison with yields of other crops; difficulties at harvest may seriously increase the cost of production, and quality of grain is often poor. Potential cash returns per acre are low by comparison with the potential return from potatoes, carrots, etc., but the inclusion of cereals in the cropping of fenland

is virtually essential to avoid too frequent cropping with potatoes and sugar beet on any but very small farms.

Sugar beet is now almost as important as potatoes to the fen farmer and there is a noticeable concentration of sugar beet factories in and around the whole fenland area (including the silts), though sugar contents are often low on the more peaty types of soil.

Prior to the introduction of sugar beet, considerable acreages of mangolds were grown, partly for feeding to stock in yards during the winter and partly for sale to stock-keepers in other parts of the country. A small area of mangolds is still to be found, but the crop has very largely been replaced by sugar beet, and indeed the whole system of fenland cropping is based as far as possible on cash crops.

Among the smaller acreage crops, carrots still occupy a considerable area, while chicory for drying has increased since the establishment of the factories at Needingworth and Lakenheath. Mustard and rape (coleseed) are grown for seed and, where the water-table is suitable, celery is an important crop.

Roads It has already been stated that from one-half to two-thirds of the area may carry potatoes, sugar beet and similar bulky crops. However suitable the land may be for the production of these crops, an important consideration in their cultivation is the harvesting and cartage of the crop from the field to market or factory. Anyone with any experience of peat will realize its unsuitability as road material, and in the past the cropping of much fenland was determined by its accessibility. Many of what on highland farms would be hard farm roads and cart tracks, capable of carrying ordinary farm traffic during the autumn, would be peat tracks or "soft roads" in the Fen. Although these are to some extent held together in the summer by grass, weeds and (particularly) couch, they are obviously unsuited for heavy carting in the autumn and early winter months.

Equally, fields which can be reached only by crossing other fields present considerable difficulties in clearing bulky crops in the autumn. There is always the temptation, therefore, to concentrate the acreage of potatoes and sugar beet on fields that are near to a hard track (which must have been made artificially as distinct from the ordinary farm cart track along a headland on highland farms) or, at least, to a soft road or driftway. This, in part, may be responsible for the seeming absence of a proper rotation of crops on individual fields, even though the farm carries the standard proportion of crops found in a typical rotation.

The importance of access, if the most suitable crops are to be grown, has led recently to the construction of hard roads in many fenland areas. These may be of gravel, chalk or concrete, depending on the presence of suitable material in the neighbourhood and the amount of capital available. In any event, such roads must be costly where materials are rarely found on or close to the site, and this was one of the problems that had to be faced in the war-time reclamation of many derelict fens.

Grass Little mention has been made of grass in connection with fenland crops. Before the war, grass was rarely found on any but the poorer types of skirt fen. Arable farming was regarded as more profitable, and the only grass on many peat fen farms was a paddock for such horses as were kept and an odd cow or two. It is, however, not easy to decide whether the absence of grass is due to the more general suitability of the land for arable cropping and the bigger potential return from arable crops or to the possible unsuitability of the area for livestock making it difficult to "cash" the grass.

In the past the most popular grass was a one-year ryegrass ley, sometimes cut for seed. It has been difficult to establish good permanent grass or long leys on fen peat soils. Clovers, though sometimes present in the first year or two, rarely persisted, and the sward rapidly deteriorated. In recent years a few farmers have attempted to apply modern methods of grassland management on the fen with some success, and the chances of establishing long leys certainly seem better now than thirty years ago.

In addition to the poorer skirt fens which were left in grass when it was considered unprofitable to use them for arable cropping, fairly extensive areas of grass exist in the so-called "Washes". These are really emergency reservoirs alongside some of the main fenland rivers. They are frequently flooded for varying periods during the winter months and improvement is therefore difficult, but they have a high reputation as grazing land and carry considerable numbers of stock during the summer months.

Livestock Reference has already been made to the fact that arable cropping is the main feature of fenland farming. On many farms no livestock of any sort are kept, but many farmers have attempted to introduce livestock into their farming systems, partly to utilize crop residues which might otherwise be wasted, and partly to supply farmyard manure. Sugar beet tops, chat potatoes, tail corn and unsaleable vegetables provide considerable quantities of stock food, whilst the cereals produce a good deal of straw that must be disposed of in one way or another.

During the summer months the absence of large areas of grazing leys reduced the stock-carrying capacity of fenland farms (except those which had access to "Wash" or other grazing), and this led to the winter fattening of cattle in yards as the chief livestock enterprise on those farms desirous of keeping stock.

A fall in prices led to the replacement of cattle by pigs in the late 1920s and the 1930s. Like many highland farmers, some fen farmers reduced their pig-keeping activities during the war, and a few returned in a small way to the feeding of cattle or carried store cattle through the winter. Recently, cattle have been used on a few farms to feed-off sugar beet tops.

Sheep have never been a prominent feature in the Fen, and though small acreages of sugar beet tops have been fed-off by sheep in recent years, this practice has been most common on farms at the edge of the Fen, often with some land out of the Fen so that the sheep spend only part of their time in the Fen consuming crop residues. Alternatively store sheep may be brought in specifically to fatten on sugar beet tops, staying no more than three to four months in the Fen. On most farms, however, beet tops are still ploughed in.

Three important considerations arise in connection with the keeping of livestock in the Fen :

First, not only are farm buildings suitable for housing livestock relatively rare, but they are difficult to erect and maintain because of the uneven sinking of the Fen, which leads to collapse of the buildings. Such buildings as exist are generally of a temporary nature, except in those places where it is possible to erect the building on a good foundation, i.e., where the peat is thin and overlies a suitable stable mineral deposit.

The second difficulty is in connection with containing livestock within the boundaries of the fields. In most fenland areas, field boundaries consist of open dykes which are an important feature in the drainage of the area and which must, therefore, be kept clear. Hence stock must be kept out of these dykes, not only for the sake of the stock but for the sake of the dyke itself, and many farmers consider it desirable to wire a field so as to prevent stock treading-in the sides of the dykes. This obviously adds to the cost.

The third consideration is a supply of water for stock. Some farms have shallow wells, but these are unreliable and many farmers have to rely on dyke water for their livestock—for those in buildings as well as those out on the land. Rainwater collected from roofs of buildings may also be used for stock in yards. This obviously creates difficulties and virtually precludes some types of livestock husbandry in parts of the Fen.

It has been said that field boundaries are often open dykes, and this is generally true throughout the fenland area. Live hedges are almost non-existent, and other forms of fencing are essentially of a temporary nature and associated only with those farms and fields which carry livestock. Trees are also relatively rare. The absence of live fence and trees may in some districts be associated with "blowing".

Fields are for the most part regular in shape, usually square or oblong. Their size is largely determined by drainage needs and they must not therefore be too large, a point that must not be lost sight of in connection with the efficiency of mechanization.

Cropping Problems On the lighter peat soils it is difficult to get a firm tilth but, in general, cultivations are easy, draught is light and periodical deep ploughing is commonly practised. The wisdom of this has been called in question in view of the difficulty of getting proper consolidation for some crops, but thorough cultivations are partly concerned with weed control.

Weeds grow even more vigorously than crops. This applies equally to annual weeds like chickweed and perennials like couch and twitch. Annuals could no doubt be controlled, in part at any rate, by the use of chemical sprays, but the Fen farmer still relies to a large extent on hoeing. Perennial weeds like couch and twitch can as yet be controlled only by proper cultivations providing an opportunity for dragging them out, collecting them up and carting them off the field to be burnt.

A good deal has been heard in recent years about the blowing of light fen soils. Blowing can be serious and may result in the removal of the top inch or so of soil. It occurs chiefly in the spring and is most severe on the light peaty fens or sandy peats that are to carry a spring crop or have already been sown with a spring crop. It may result in the complete removal of the surface soil, together with sown seed, involving the complete resowing of the field sometimes two or three times in one season. What is worse, the blown soil may be deposited in the open ditches, thereby blocking the drainage system of the area and involving additional expense in cleaning out the ditches before the next winter if the land is not to be waterlogged.

The trouble is less serious and less prevalent on fens that have been "clayed". By "claying" is meant the excavation of underlying clay or silty clay material for spreading on the surface of the ground. This practice was common prior to 1917, but has become increasingly rare since that time owing to the amount of labour required and the cost involved. The cost will be appreciated when it is realized that the operation usually involves the spreading of some 200 tons of clay per acre.*

Opportunist cropping and neglect of the common principles of crop rotation have from time to time brought trouble to the Fens, particularly in the shape of potato root eelworm and sugar beet eelworm. To devise a cropping sequence which will achieve the potential maximum output from Black Fen, and yet at the same time have proper regard for the principles of crop rotation, is not easy in the Fen peat districts.

* An article by R. B. Ferro and A. C. Middleton on the costs of marling in East Yorkshire appeared in the June issue of *Agriculture*.

The Fen farmer has always tended to look at each crop as an individual, almost as a separate part of his farming activities, and to assess its value on the basis of its direct cash return. This outlook can only lead to trouble until such time as other methods of control of pests and diseases are available. The effect of a crop on the soil and on succeeding crops is of first importance.

There is, of course, no dearth of other pests in the Fen, but I have mentioned these two because of their outstanding importance in Fenland agriculture and the need for a proper realization of this in the interests of the future of Fenland farming.

Of diseases, Potato Blight must obviously be of importance in an area such as this where humid conditions are so liable to develop during the summer months and where the prosperity of the area depends so largely on the potato crop.

The only other disease I would mention as being perhaps specially favoured by conditions in the area, as compared with conditions in other parts of the country, is mildew of cereals, which can develop to an almost unbelievable extent in some seasons.

Trouble may also arise sometimes from trace element deficiency.

Labour No account of Fenland agriculture would be complete without some reference to labour. For the most part, the population of the Fenland districts is concentrated in villages, usually on one or other of the islands already mentioned as being outcrops of the mineral formation (clay or gravel) or on the edge of the adjacent highland. This distribution is necessitated partly by the difficulty of building in the Fen (already mentioned), difficulties of water supply and the provision of other amenities in the Fen, and by the general unwillingness of most people to live in the Fen itself.

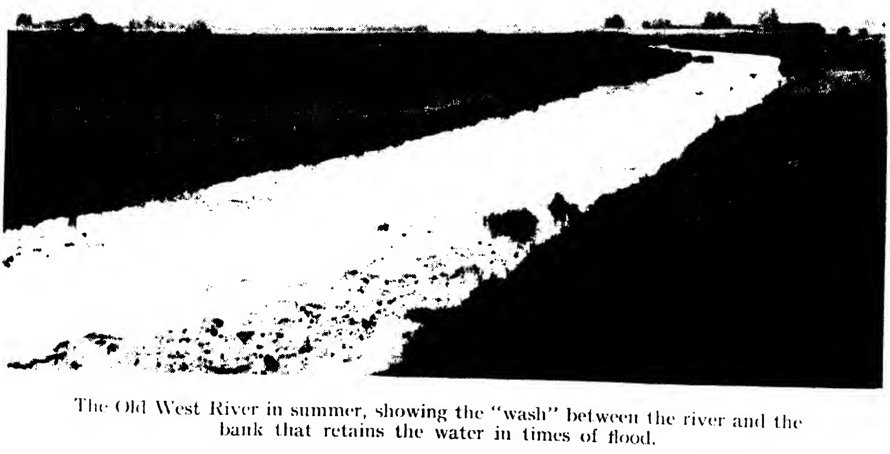
The Fen worker is one of the most efficient and highly skilled agricultural workers in the country, and though the Fen farmer has not been slow to avail himself of labour-saving machinery, the amount of manual labour involved in the growing of the root and vegetable crops in particular is still large. Much of the work is done piece-work and a great deal is done on a casual basis by the family of the permanent farm worker, particularly in connection with planting and lifting potatoes, singling, hoeing and lifting of sugar beet.

The large proportion of smallholdings in the Fen has resulted in many workers having a small 5- or 10-acre holding of their own whilst working for a larger farmer, and the proportion of large farms is not high. Smallholdings have developed on a large scale in the Fenland areas. The productivity of the land, combined with its relatively easy working nature, makes it specially suitable for this purpose.

The intensive nature of the agriculture of the Black Fen is shown by the fact that farm capital, manual labour and gross output per 100 acres are all very high, often double the comparable figures for adjacent highland farming.

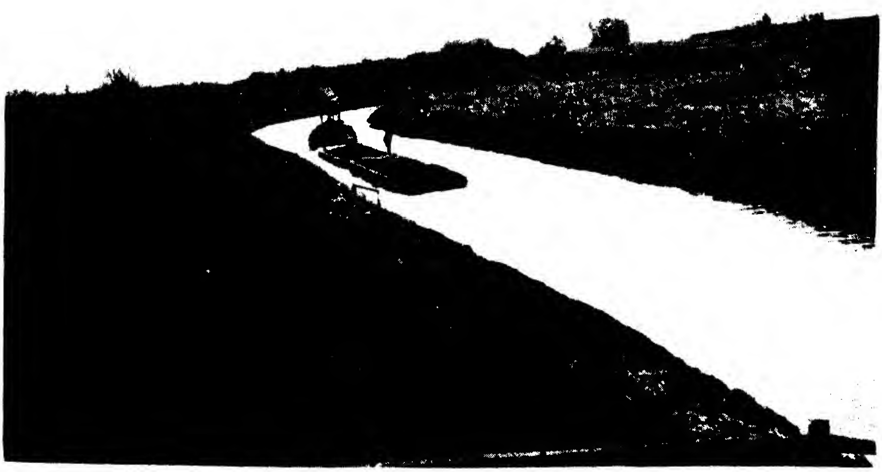
Wicke Sedge Fen, in the possession of the National Trust, showing land in its original condition, similar to that which has been reclaimed by drainage. This land and that on Burwell Fen is some 15 feet below sea level.

Bog oak from adjoining fields lying alongside a concrete road. Near the surface they interfere with cultivations and must be removed. Some are more than 70 feet long.



The Old West River in summer, showing the "wash" between the river and the bank that retains the water in times of flood.

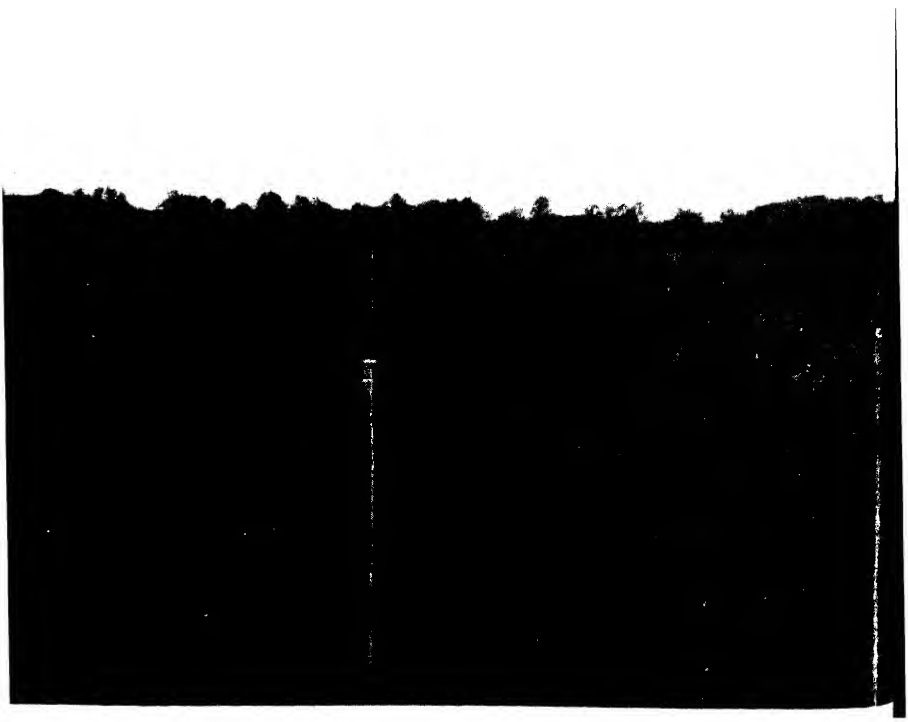
Fenland rivers are embanked to carry flood waters.



The larger watercourses have their uses. Barges conveying sugar beet to the local factory.

THE OUTWINTERING OF BEEF STORES ON GRASSLAND (See pp. 200-3)

Block A. Range grazed.



Block B. Divided into twelve paddocks by electric fencing.

RECENT RESEARCH ON WIREWORMS

I. THOMAS, M.Sc., Ph.D.
Ministry of Agriculture and Fisheries
Plant Pathology Laboratory, Harpenden, Herts

IN a report by the Advisory Entomologists' Conference of a wireworm survey of England and Wales undertaken in connection with the ploughing-up campaign in 1939-42*, a sampling method described for estimating wireworm populations led to the possibility of reliable practical advice being given to farmers throughout the country. As a result of figures obtained and experience gained from sampling large numbers of fields, it was possible for advisers to suggest cropping adjustments which often helped farmers to avoid serious losses. It was previously known that some crops, e.g., peas and beans, were much more resistant to wireworm attack than others. This knowledge was considerably extended, and as a result of advice given many war-time cropping programmes were modified, thus leading to considerable increases in food production. Advice based on the results of this survey is still given, but meanwhile there have been many important advances in our knowledge of the wireworm problem, and it is the purpose of this article to describe the progress of research on wireworms in this country since the issue of the report in 1943.

Evidence from the survey indicated that spring oats is one of the farm crops most susceptible to wireworm attack, and trials with this crop were therefore continued throughout the country. These were described by Finney and Jary(1), who showed that in fields with high wireworm populations the chance of a satisfactory crop of spring oats is increased considerably by sowing extra seed ; 50 per cent extra seed increased the yield by as much as 3-5 cwt. of grain per acre. A similar though less marked effect was produced by cross-drilling seed without any increase in the total amount sown.

Observations on wireworms in the sugar beet crop, by Price Jones and F. G. W. Jones(2), also emphasized the importance of an increased seeding rate as a control measure. Increasing the seed rate from 14-16 lb. per acre to 17-25 lb. per acre in fields of high wireworm population gave significantly higher plant populations in most trials and also an increase of 15 per cent in total sugar in the one trial harvested. Interdrilling with wheat to act as a trap crop at 40-70 lb. per acre gave increased plant populations of sugar beet before and after singling. It was recognized, however, that neither interdrilling with a trap crop nor extra seeding was an ideal way of dealing with wireworms because, paradoxically, control depended on giving the insects extra food. It was important, therefore, to press on with research already under way.

New Methods The estimations of wireworm populations described in Bulletin 128 were based on a hand-sorting method of examining the samples. This was adopted because no other quick method was available at the time and the need for the work was urgent. The figures obtained provided a basis for practical advice, but it was realized that the numbers of wireworms found by this method by no means represented the total population present, and a study of methods of extracting all wireworms, including the very small ones, from the soil was undertaken at the Department of Zoology, Cambridge, by Salt and Hollick(3). These workers evolved and described a mechanical method which provided for the extraction of complete populations of insects from soil samples. They showed that, as with all animals,

* *Ministry of Agriculture Bulletin* 128, "Wireworms and Food Production". H.M. Stationery Office. Price 1s. (1s. 2d. by post).

in order to maintain a certain population of fully-grown individuals, far larger numbers of young have to be present because of high mortality in the early stages. An animal population may thus be represented by a pyramid or cone in which the large numbers of small individuals, newly-hatched from eggs, form the base and diminishing numbers of larger individuals are found until a comparatively small number of fully grown individuals or adults survive at the apex. Salt and Hollick showed that approximately 60 per cent of the wireworm population in grassland consists of larvae less than ¼-inch long. Very few of this size were found by the hand-sorting method. Total extraction showed that the wireworm populations of some fields totalled more than ten million per acre, and of some small areas more than twenty million per acre.

Using the new extraction apparatus, these workers(4) were able to study wireworm populations much more accurately than had hitherto been possible. They set out to find how wireworms were distributed in a fairly small area, what caused the distribution, and how the observed distribution came about. They found that over a period of three years some spots in a field were consistently three or four times as heavily infested as others only 4 yards away. Within the ¼-acre plot studied intensively the amount of soil moisture at a depth of 3 inches was found to be the most important factor. Other factors correlated with wireworm numbers were the amount of organic matter and nitrogen in the soil and abundance of certain grasses and certain other insects. The authors emphasized, however, that much more work on the ecology of wireworms would be needed before a full explanation of some of their findings could be expected.

The final paper in this series by Salt and Hollick, dealing with the effect of cultivations on wireworm populations, was published recently(5).

Using the laboratory apparatus as a basis, Hollick designed and supervised the building of a prototype of an ingenious and intricate machine for the rapid and complete extraction of all wireworms from soil samples. This machine is, in principle, a combination of four units of the type of apparatus built by Salt and Hollick in the laboratory. It was designed so as to make it possible, after soaking the samples for twenty-four hours, to put them in at one end of the machine and count the wireworms extracted at the other. The prototype machine was thoroughly tested at Rothamsted and was shown to be very efficient. Over 99 per cent of the wireworms present in a sample could be recovered and five or six samples per man-hour could be handled. Other soil-inhabiting insects could also be extracted, but for some purposes the machine will probably prove to be too intricate and costly.

About this time, and following the development of the Salt and Hollick small-scale wireworm apparatus, another team of Cambridge workers, Cockbill, Henderson, Ross and Stapley (6), using the same principle, constructed a large-scale flotation apparatus for extracting wireworms from the soil. The apparatus was less intricate and much cheaper than the Hollick extraction apparatus described above. These workers did not aim at the extraction of all wireworms, including the very small ones, as with the Hollick machine; nevertheless it was found in practice that over 95 per cent of the wireworms were extracted. By this method ten samples of soil (4 inches in diameter and 6 inches deep) bulked together could be examined at one time and could be dealt with at the rate of thirteen samples per man-hour. Small-scale models of the apparatus have been installed at some provincial advisory centres and have helped to increase the accuracy of wireworm sampling work.

Laboratory Studies While the above work was proceeding other workers at the Zoology Laboratory, Cambridge, undertook studies on the "behaviour" of wireworms. When kept in dry conditions wireworms are liable to lose weight very quickly—due to loss of water through the skin or cuticle. Lees(7), however, showed that by means of certain minute sense organs on the head, wireworms are able to avoid dry air. He also showed(8) that wireworms will quickly migrate out of dry sand and collect together in wet sand, and that the feeding activity of a small population of larvae was much greater at low than at high temperatures. Falconer(9), of the same laboratory, showed that the resistance of wireworms to low temperatures was greatly influenced by the rate at which the temperature was reduced. For instance, a sudden drop in temperature to about 19°F. (13 degrees of frost) killed all the wireworms in four hours, but when the temperature was lowered gradually a few survived for at least a day at 14°F. (18 degrees of frost); it was concluded that very few, if any, wireworms are likely to be killed by the temperatures normally encountered in soils in this country. Falconer(10), also found that wireworms are extremely sensitive to light, but their objection to light did not prevent their emerging from the soil and crawling on the surface if the atmosphere was sufficiently moist.

Thorpe and Crombie, co-operating with Hill and Darrah(11), of the Agricultural Research Council Unit of Plant Biochemistry, Cambridge, studied the behaviour of wireworms in response to chemical stimulation, with a view eventually to using a baiting method for their control. Two types of apparatus were used; one tested the biting reaction of wireworms, and the other—"a soil choice chamber"—their ability to aggregate in sand or soil mixed with certain test chemicals. They found a definite response to pure sugars but a much increased activity in response to potato juice with the starch grains removed. Certain colourless crystals, later found to be a chemical known as asparagine, isolated from the juice, stimulated the wireworms to even greater activity; further, it was shown that aggregation of wireworms was also caused by a number of compounds related to asparagine. The authors concluded that "the prospects of diverting an attack from the

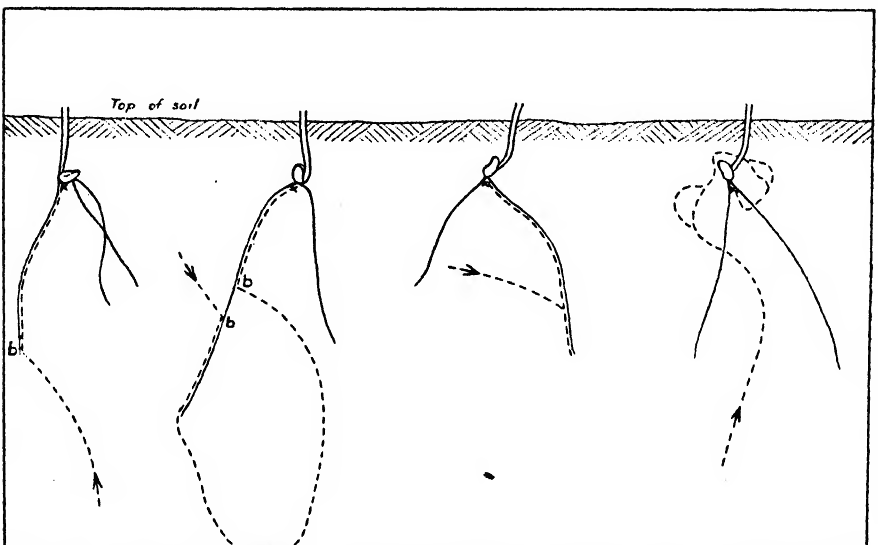


Fig. 1. Tracks made by wireworms in the region of germinating wheat. The arrows represent the position and direction in which individuals started, the crosses where they finished and began feeding on wheat grain. The letter *b* indicates points at which the root was bitten.

critical early stages of a crop are encouraging. The best time for this would presumably be before the wireworms have had the chance to establish burrow systems directly associated with the plants. The efficiency of any baiting method can, on the conclusions we have drawn from the work here described, readily be seen to depend greatly on the type and condition of the soil. To bring the bait method to its fullest practical efficiency in wireworm control the aim should be to produce a bait substance resistant to bacterial attack. This should then be mixed with a non-repellent contact poison. On these lines the method might have a wide application."

This work was continued and extended by Crombie and Darrah(12). They found that certain compounds to which wireworms respond are secreted in small amounts by the roots of growing plants (Fig. 1) and that the root system of plants probably forms an extended trap along which the wireworms may be led to the grain or tuber in the centre, where a wound caused by their random biting would release active compounds in sufficient concentration for them to remain and feed.

Work on the biology and physiology of wireworms was also continued at Rothamsted by Evans(13). The growth, feeding activity and moulting frequency of a population of wireworms were studied over a period of three years. It was shown that growth was strongly influenced by food; wheat and carrots permitted rapid growth, grass and clover slower growth, and on mustard and potatoes wireworms just maintained their weight; wireworms fed on flax actually lost weight. It was also shown in a field experiment that beans grown on a broken-up old pasture had the effect of reducing the population to a level at which a good crop of oats (28.5 cwt. per acre) was grown in the following year. In the same experiment, yields after grass and wheat were approximately 19 cwt. per acre, after sugar beet and barley 15 cwt., after flax 12 cwt., and after potatoes and oats 10 cwt. From observations made subsequently in other parts of the country it would appear that a bean crop does not always have such a marked effect on wireworm populations.

Field Studies Following the development of their large-scale washing apparatus, Ross, Stapley and Cockbill(14), in addition to examining many thousands of samples in the course of routine advisory work, investigated wireworm population changes on a field scale. Six grass fields were sampled intensively once a fortnight from July, 1943, to September, 1944: samples taken to depths of 12 and 24 inches showed that about 75 per cent of the wireworms were found in the top 6 inches but that a small proportion often occurred at depths below 1 foot.

The population changes after ploughing from grass and summer fallowing(15) were followed in six other fields. Only in two of these was there some reduction in the population in the first autumn and winter, and not until the first crop had been harvested was there a marked permanent reduction (30-70 per cent) in all the fields. This work was followed up in 1943 and 1944 by studying the population changes during a bare fallow(16) in no less than twenty-three fields. The results fully supported the views held by farmers that a bare fallow greatly reduces the numbers of wireworms and subsequent damage to crops. Populations were reduced in every case—sometimes to less than 10 per cent of the original level—wireworms of all sizes were affected, and almost all the smallest were killed (Fig. 2). The reduction was greater in fields ploughed in February and March than in fields ploughed in May. As a result of this work, therefore, it was possible to give further sound practical advice about cultural operations in relation to wireworm control.

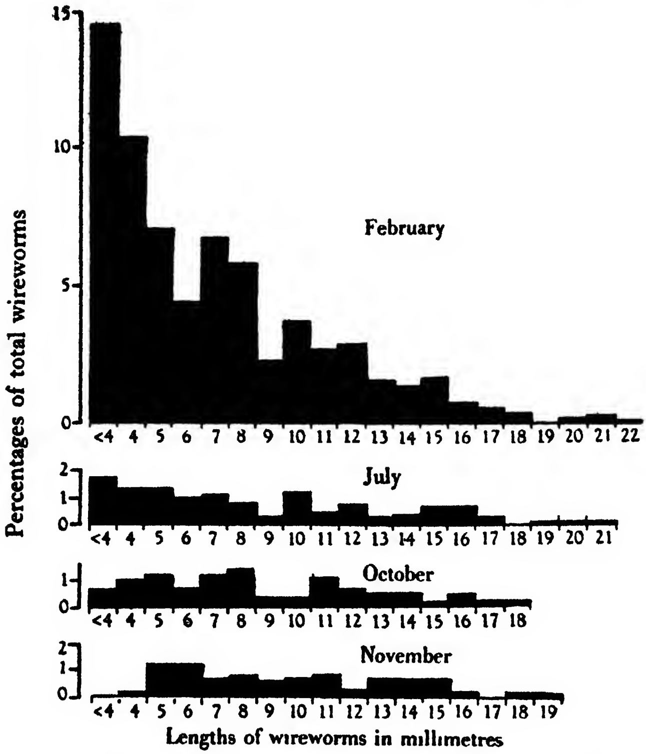


Fig. 2 Size distribution of wireworms from seven fallows taken together at four successive samplings, expressed as a percentage of the total number of wireworms found.

In their final contribution on wireworm populations in relation to crop production Ross, Stapley and Cockbill([17]) compared the wireworm populations in failing and successful plots. They found that the wireworm-damaged areas did not in all cases have the higher populations ; they also found that the calcium carbonate content of the soil was consistently higher and the sand content consistently lower in the plots suffering most from wireworm damage. There was a suggestion, too, that wireworm attack commonly follows sainfoin. These workers refer to developments in chemical methods and conclude that the most effective use of a chemical treatment depends on reliable predictions about the probability of wireworm attack and that "it would be wrong to believe that the need has passed for field and laboratory studies which aim to provide a sounder basis for predicting wireworm damage".

Concurrently with the work on the wireworms themselves, studies of the adult click beetles have continued. There is always a possibility that a method of trapping and destroying the adults will be discovered, so that it is important to have a knowledge of their habits and preferences. At Rothamsted, Gough and Evans([18]), and later Brian([19]), studied the ecology of the more important species : for this work Brian developed a new electronic detection method for tracing movements of the click beetles in the soil. He also carried out extended trials with the large-scale Hollick extraction machine described above.

The behaviour of adult click beetles was also studied at the Midland Agricultural College where Roebuck, Broadbent and Redman([20]) tried various methods of trapping and attracting the beetles. The most suitable trap

proved to be a 3-inch layer of hay placed over closely clipped grass. It was shown that maximum activity occurred in late May and early June during the afternoons and evenings.

Chemical Control The mosts triking advance in recent years towards solving the practical problem of controlling wireworms has undoubtedly been the discovery of the insecticidal properties of the chemical benzene hexachloride (BHC). Hitherto no satisfactory chemical means of dealing with wireworms has been known. Now all the older soil insecticides for the control of soil insects have been almost entirely superseded by DDT and BHC ; for the control of wireworms in particular, BHC is outstanding.

Following the discovery in 1942-43([21]) of the value of the gamma isomer of BHC (gammexane) as a powerful insecticide, workers at the Hawthorndale laboratories, Jealott's Hill, concentrated on its possible use for the control of wireworms, and in 1947 Jameson, Thomas and Woodward([22]) reported that BHC containing 13 per cent of the insecticidally active gamma isomer had been used successfully against wireworms in a number of large-scale field trials. There were three methods of application :

1. Broadcast—usually as a 2 per cent dust at 1½-6½ cwt. per acre ;
2. Combine drilled—usually as a 2 per cent dust at ¾-1½ cwt. per acre ;
3. As a seed dressing—(8 per cent gamma isomer) at 5 oz. per bushel of seed.

In general, the experiments showed that in conditions of heavy wireworm infestation of winter wheat and spring oats, twofold to fivefold increases in grain yield were obtained with the broadcast dressing, using 3 cwt. of a 2 per cent dust (=6 lb. of BHC per acre), and with the combine drill dressing, using 1 cwt. per acre of the same dust (=2 lb. of BHC per acre) : only slightly lower increases in yield were obtained with the seed dressing. In general, wireworm populations in these experiments were reduced to about one-third, one-half, and three-quarters respectively by the three treatments.

These results have been amply confirmed in numerous experiments in various parts of the country, and at Rothamsted in 1948 BHC as a seed dressing and broadcast was tested in trials which also included the soil fumigants, ethelyne dibromide and D-D. In addition to BHC, the ethelyne dibromide treatment appeared to be particularly promising, and it remains to be seen whether the effect of these insecticides has been carried over into the 1949 crops. Particular attention will also be paid this year to the question of tainting of subsequent crops. BHC insecticides are, unfortunately, not without their disadvantages, and at present they are not recommended for use on soils to be cropped in the same year or either of the two following years with potatoes, onions, carrots and other root vegetables for human consumption, because there is a risk that flavour may be affected. Nevertheless, up to the present, BHC insecticides represent a very great advance in the use of chemicals for the control of wireworms.

Team Work Wireworms have always been regarded as the chief insect pests of agricultural crops in this country, and entomologists have given much thought and time over a long period of years to the problem of their control. In 1938-39 this work was intensified and the Agricultural Research Council set up a Conference to co-ordinate and initiate further work. The contributions described in this paper are the results of much patient investigation by research workers at universities, Government research stations, the research stations of commercial firms, and by advisory entomologists ; farmers themselves have also contributed in no small measure by their generosity and willingness to lend their fields and crops at all times. Now that a chemical control measure is available, a milestone in

wireworm research has been reached, but the aim must always be prevention of attack. Farmers must not on any account sit back and call for help when the damage has been done; rotations must be carefully considered, and cultural methods for reducing populations combined with the chemical methods where damage is likely to occur. Occasionally, detailed knowledge of the local conditions and the geographical location of a field are enough in themselves to enable an experienced adviser to say whether a particular field is likely to have a high wireworm population, but probably the field will need to be sampled; if a high population is found further advice will depend on the particular circumstances, e.g., (*a*) the field may be best left unploughed; (*b*) the rotation may be modified; (*c*) a bare fallow—ploughed early—may be advocated; (*d*) the rotation may not be modified, but treatment with BHC may be advocated; or (*e*) a combination of modified cultural operations, modified cropping and chemical treatment may be advised. It will be seen, therefore, that advisory officers are now in a stronger position than hitherto to advise on wireworm problems. The help of District Officers and Advisory Entomologists should be sought before ploughing up old grassland, especially those fields known to have a "wireworm history".

References

1. FINNEY, D. J. and JARY, S. G. Wireworms and Spring Oats. *Agriculture* (1946), **52**, 11, 491.
2. PRICE JONES, D. and JONES, F. G. W. Wireworms and the Sugar-beet Crop: Field Trials and Observations. *Ann. appl. Biol.* (1947), **34**, 4, 562.
3. SALT, G. and HOLLICK, F. S. J. Studies of Wireworm Populations, I. A Census of Wireworms in Pasture. *Ann. appl. Biol.* (1944), **31**, 1, 52.
4. SALT, G. and HOLLICK, F. S. J. Studies of Wireworm Populations, II. Spatial Distribution. *J. exp. Biol.* (1946), **23**, 1.
5. SALT, G. and HOLLICK, F. S. J. Studies of Wireworm Populations, III. Some Effects of Cultivation. *Ann. appl. Biol.* (1949), **36**, 2, 169.
6. COCKBILL, G. F., HENDERSON, V. E., ROSS, D. M. and STAPLEY, J. H. Wireworm Populations in Relation to Crop Production, I. A Large-scale Flotation Method for Extracting Wireworms from Soil Samples and Results from a Survey of 600 Fields. *Ann. appl. Biol.* (1945), **32**, 2, 148.
7. LEES, A. D. On the Behaviour of Wireworms of the genus *Agriotes* Esch. (*Coleoptera, Elateridae*) I. Reactions to Humidity. *J. exp. Biol.* (1943), **20**, 1, 43.
8. LEES, A. D. On the Behaviour of Wireworms of the genus *Agriotes* Esch. (*Coleoptera, Elateridae*) II. Reactions to Moisture. *J. exp. Biol.* (1943), **20**, 1, 54.
9. FALCONER, D. S. On the Behaviour of Wireworms of the genus *Agriotes* Esch. (*Coleoptera, Elateridae*) in relation to Temperature. *J. exp. Biol.* (1945), **21**, 1, 17.
10. FALCONER, D. S. On the Movement of Wireworms of the genus *Agriotes* Esch (*Coleoptera, Elateridae*) on the Surface of the Soil and their Sensitivity to Light. *J. exp. Biol.* (1945), **21**, 1 and 2, 33-8.
11. THORPE, W. H., CROMBIE, A. C., HILL, R. and DARRAH, J. H. The Behaviour of Wireworms in Response to Chemical Stimulation. *J. exp. Biol.* (1947), **23**, 3 and 4, 234-66.
12. CROMBIE, A. C. and DARRAH, J. H. The Chemoreceptors of the Wireworm (*Agriotes* sp.) and the Relation of Activity to Chemical Constitution. *J. exp. Biol.* (1947), **24**, 1 and 2, 95-109.
13. EVANS, A. C. Observations on the Biology and Physiology of Wireworms of the genus *Agriotes*. *Ann. appl. Biol.* (1944), **31**, 3, 235.
14. ROSS, D. M., STAPLEY, J. H. and COCKBILL, G. F. Wireworm Populations in Relation to Crop Production, II. Population Changes in Grassland. *Ann. appl. Biol.* (1947), **34**, 1, 66.
15. COCKBILL, G. F., ROSS, D. M. and STAPLEY, J. H. Wireworm Populations in Relation to Crop Production, III. Population Changes after Summer Ploughing. *Ann. appl. Biol.* (1947), **34**, 1, 83.
16. STAPLEY, J. H., ROSS, D. M. and COCKBILL, G. F. Wireworm Populations in Relation to Crop Production, IV. Population Changes during a Bare Fallow. *Ann. appl. Biol.* (1947), **34**, 1, 95.

17. Ross, D. M., Stapley, J. H. and Cockbill, G. F. Wireworm Populations in Relation to Crop Production, V. Comparisons between Failing and Successful Plots. *Ann. appl. Biol.* (1948), **35**, **2**, 193.

18. Gough, H. C. and Evans, A. C. Some Notes on the Biology of the Click Beetles *Agriotes obscurus* L. and *A. sputator* L. *Ann. appl. Biol.* (1942), **29**, **3**, **175**.

19. Brian, M. V. On the Ecology of Beetles of the genus *Agriotes* with special reference to *A. obscurus*. *J. anim. Ecol.* (1947), **16**, 2, 210.

20. Roebuck, A., Broadbent, L. and Redman, R. F. W. The Behaviour of Adult Click Beetles of the genus *Agriotes* (*A. obscurus* L. *A. lineatus* L. and *A. sputator* L.). *Ann. appl. Biol.* (1947), **34**, 2, 186.

21. Slade, R. The Gamma Isomer of Hexachlorocylohexane (Gammexane). *Chem. and Ind.* (1945), **40**, 314.

22. Jameson, H. R., Thomas, F. J. D. and Woodward, R. C. The Practical Control of Wireworm by γ-Benzene Hexachloride ("Gammexane") : Comparisons with Dichlorodiphenyltrichlorethane (D.D.T.). *Ann. appl. Biol.* (1947), **34**, **3**, **346**.

FARM GRAIN STORAGE

W. A. Hayles

National Agricultural Advisory Service, East Midland Province

MORE and more grain is being cut with combine harvesters. At least 7,500 machines will be at work this year, and by 1950 it is estimated that the number will have risen to 11,000. Bulk storage to hold some of this grain is being installed by merchants; it is, however, becoming more than ever necessary for farmers to install equipment capable of storing at least part of the combined cereals.

In such circumstances it is essential that the grain should be in a fit condition for storage. It should be reasonably clean and free from greenstuff, and the moisture content should be reduced to 15-16 per cent ; provided elementary precautions are taken, at this figure the grain may be stored satisfactorily under farm conditions up to six months. Good keeping depends just as much on the condition of the grain as on the type of container used to hold it.

Storage in Sacks The sack is a very efficient container for combined grain that is not too damp, provided precautions are taken to prevent moisture rising from the floor through the bottom of the sack. An upper floor is best for storage ; if, however, the ground floor has to be used, a temporary, wooden slatted floor, to prevent rising damp and to allow air circulation under the sacks, will help to keep the grain in the lower part of the sack in good condition. Storage in sacks can prove costly if it is used for long periods, owing to the expense of hire or purchase of the sacks and the risk of damage by vermin. Handling costs are more expensive than with bin storage and power conveying ; grain may however be stored in a sack at a slightly higher moisture content than in a bin.

Pre-cast Concrete Bins One type of bin commonly used is of circular form, constructed of pre-cast concrete slabs. This is available in ten sizes, ranging in diameter from 8 feet 1 inch to 15 feet 1 inch, and can be erected to any convenient height up to 20 feet. The bins are built up from ground level with pre-cast tongued-and-grooved concrete staves, the internal pressure being taken by adjustable steel wires or rods placed horizontally round the outside of the bin.

These bins, which at the moment are in good supply, provide a cheap form of container and can be erected with the minimum of skilled workers; much, if not all, of the work can be done by farm labour. They also have the advantage of being easily dismantled and re-erected. The use of circular bins in square or rectangular buildings can lead to a serious waste of the available floor space. The bins are fireproof, but the outside surface must be specially treated to make it weatherproof.

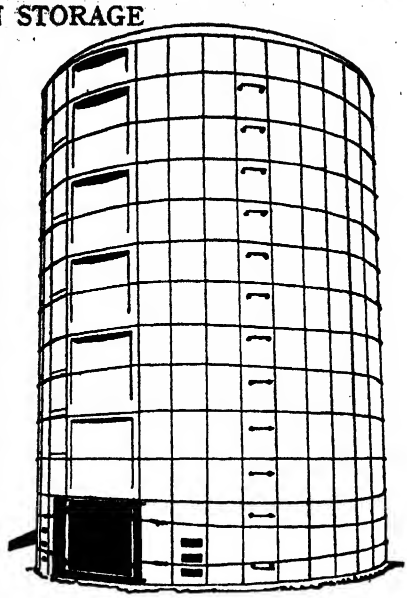


Fig. 1. Circular bin constructed from pre-cast concrete staves. Note inverted louvres near bottom.

Another type of concrete bin may also be constructed from hollow pre-cast sections. The bins are square and are formed by building up successive layers of the sections, which have *cranked* ends to provide a space in which is cast, *in situ*, a column of reinforced concrete. The units are made to form a standard 10 feet square bin. The method of construction allows any number of bins to be built together and carried up to suit the height of the eaves of the building. A self-emptying hopper bottom may be fitted if desired. The bins are weather- and vermin-proof, and require no maintenance.

Brick Bins A satisfactory type of bin may be constructed from bricks laid in cement. All the walls will need to be in 9-inch work, with the partitions and external corners bonded for maximum strength; additional strength at these points may be obtained by building into the brickwork suitably shaped iron tie rods. Under a height of 10 feet, for bins of up to 25 tons capacity, it should not be necessary to use internal iron cross tie rods. If Flemish bond is used the wall can be reinforced by building in at convenient intervals a series of ⅜-inch diameter steel tie rods placed vertically; additional strength may be obtained by bedding the lower ends of the rods into the concrete floor. If the bins are over 10 feet high, they should be cross tied in both directions by metal rods, with substantial plates on the outer surface of the walls. To prevent rising damp it is advisable to insert a damp course near ground level. This type of bin is fireproof and

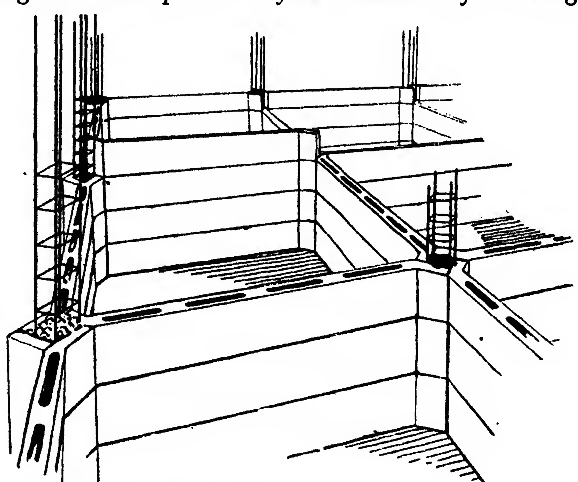


Fig. 2. Square bins built up from pre-cast concrete sections. Note reinforcement at angles.

can be constructed from readily obtainable materials. Skilled labour is needed for its erection, and once put up it cannot be dismantled and re-erected.

Wooden Bins Wood is one of the most suitable materials for the interior surface of a grain storage bin. A common method of constructing square or rectangular bins is by building the walls up from floor level by nailing successive lengths of wood, 2 inches × 2 inches or 3 inches × 2 inches laid flat, into each other. The external corners should be tied by running alternate lengths through to the outside; partitions can be tied to the outer walls in the same way. As the walls are being built up over the whole lay-out, care should be taken to keep them straight and vertical; this can best be achieved by erecting a number of temporary vertical members, against which each layer is placed before nailing down. Any ties or ladder rungs in the internal angles should be built in as construction proceeds.

An advantage of this method of construction is that the walls are thin and the bins may be made to fit closely into any available space, together with the fact that much of the constructional work can be carried out by unskilled labour. These bins are not fireproof and they cannot easily be dismantled for erection elsewhere. At the present time timber is both expensive and scarce.

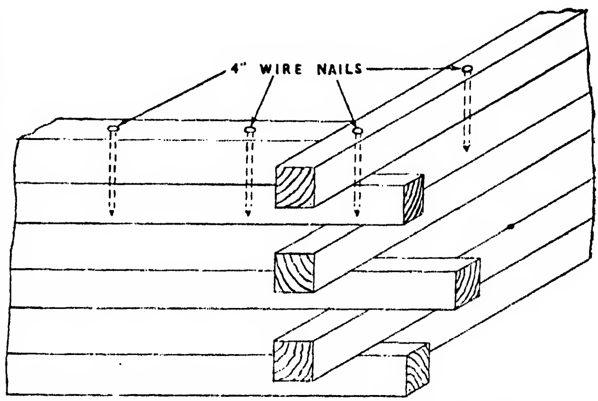


Fig. 3. Corner of bin constructed from 2″ × 2″ wood.

Another type of bin constructed mainly of wood can be made by building up timbers on edge between H section steel stanchions. The timbers, which are put in from the top, must be cut just long enough to drop in the vertical grooves formed by the stanchions. The external corners of the bins are formed by the erection of two adjacent H section members arranged to provide grooves at right angles. The thickness of the timber should be related to the length of carry, which is determined by the distance between the stanchions. As the timbers do not hold the bin together, the outward thrust must be taken by tying in the vertical members across the top of the bin.

Ventilated Bins Grain may be ventilated in the bin by making provision for a current of air to pass up through the mass of grain. This type of bin may be divided into two classes: those which rely on natural air currents for ventilation, and those where forced ventilation is carried out by means of a fan.*

For natural ventilation the air may enter through suitably shaped openings in the walls of the bin; these may be either near the ground or all the way up the sides of the bin. In some cases the openings take the form of a series of inverted louvres built into the lower parts of the walls, thus permitting the entry of air without allowing the grain to run out. Another type

*R. A. Vinter. Storage Drying of Grain. *Agriculture* (February, 1949), 488.

of bin which makes provision for natural ventilation throughout the height of the walls, is constructed from concrete beams 9 inches deep; the beams are truncated cone shape in section. Each side of the bin is formed by successive horizontal layers of the beams, which are erected with a ½-inch air space between them. Each beam is placed with the thicker edge at the bottom, thus providing an overhang to the beam below; although a space exists between the beams, the angle of repose of the grain from the lower overhanging edges does not allow grain to escape.

In some cases additional ventilation is provided by building in across the bins a series of hollow triangular ducts, thus allowing air to circulate through the bin in contact with the grain. If possible, it is an advantage to place these ducts in the direction of the prevailing wind. Experiments carried out in this country and the U.S.A. together with a study of the principle involved, tends to throw considerable doubt on the effectiveness of this method of ventilation.

Forced ventilation is carried out by blowing a current of air into the lower part of the bin and allowing it to pass up through the column of grain. This method can be used successfully to prevent or reduce heating of the grain in the bin. Within the limits set by the relative humidity of the air used for ventilation, it will also provide a means of slowly drying the grain in shallow layers; it cannot, however, be regarded as a satisfactory substitute for a grain drier in the higher rainfall districts. A well-designed system of ventilated bins will provide storage and facilities for limited drying for the smaller farmer in those areas where part of the crop may be gathered at a moisture content slightly above the safe storage limit.

If provision is made to ventilate grain in the bins it will inevitably add to the cost of storage installation. The walls and bottoms of the bins must be airtight, a horizontal false floor which will hold grain and yet permit air to pass through must be provided, while a suitable fan and motor, together with the necessary ducting, will be needed.

It is possible to install a heater to raise the temperature of the air slightly before it is passed through the grain. This will allow ventilation to be carried out irrespective of weather conditions; it will, however, increase the cost and tends to complicate management, but where ventilation is provided for, some provision for heating the air might well be considered.

Bin Floors At some stage it will be necessary to decide whether the bins are to have a sloping or horizontal floor, i.e., self-emptying or otherwise. The self-emptying bin will save a certain amount of labour; but it reduces storage capacity considerably. If a self-emptying bottom, sloping at 45 degrees, is built into a bin 15 feet high and 10 feet in diameter, its capacity is reduced by one-third; the percentage reduction in capacity is greatest in the larger diameter bins of low height. Where bins are raised above ground level, the disadvantages of self-emptying are not so great, since it is usually possible to slope the floor to a central discharge point.

To avoid the loss of storage capacity, a compromise can be made with bins at ground level by constructing the floor with a slope of 15 degrees towards the discharge point. In most cases farm storage installations call only for the occasional discharge of bins; when this is being carried out there is usually a man in attendance who can keep the grain running and finally sweep the bin out.

Conveyor Systems Some means must be provided for moving the grain to and from any part of the storage system. Provision must be made for passing the grain from the wet pit to the drier or

dresser before it is placed in the storage bins. A sacking-off point will be needed to allow grain to be sacked off from the bins either direct or through the dresser. The installation of the conveying equipment is a specialist job. Before any work on the building or storage bins is started, it is desirable to seek the advice of the firm who will provide and fix the equipment. Two distinct types of conveying equipment are commonly used in farm grain storage installations—mechanical and pneumatic. Each has its advantages and disadvantages. In many instances a satisfactory compromise has been reached by using a mechanical elevator for the short vertical lift and the pneumatic conveyor for the longer and mainly horizontal distances.

Mechanical Conveyors and Elevators With this type the grain is moved by means of a worm or an endless belt carrying cups, rings or slats, and running in a wooden trunk or steel duct. This method is best suited for the shorter distances, especially the vertical lift; for example, from the wet grain pit to the drier or dresser. For a similar conveying rate and distance, the power required for this method is lower than that needed for a pneumatic conveyor. Care must be exercised when changing from one type of grain to another, as this system is not self-cleaning. The grain is moved in a mass, as distinct from the pneumatic type, which provides a greater degree of separation during conveying.

Pneumatic Conveyors The grain is conveyed by a high velocity air stream inside a steel duct 6 to 9 inches in diameter. The air stream is supplied by a suitable fan designed to match the conveying rate, the size of the duct and conveying distance. The fan is best driven by an electric motor, but an internal combustion engine may be used if mains current is not available.

The pneumatic conveyor allows a degree of flexibility which can be varied to suit the size of the installation. For the larger installations the motors, fans and ducting would be fixed permanently; for the smaller installation the motor, fan injector and ducting may be portable, the power unit being moved and the ducting arranged to suit the conveyance required. In some cases a compromise is made by having certain sections of ducting permanently fixed while the portable power unit fan and injector is coupled to them as required by suitable lengths of duct. When this method is adopted it is possible to use lengths of flexible rubber duct which can be coupled to the rigid metal sections. To avoid damaging the grain the minimum number of bends should be used, while care should be taken to inject grain at the correct conveying rate. To lower the velocity of the grain when discharging into a bin, reducers should be fitted to the discharge ends; care should also be taken to avoid discharging the grain against the side of a bin. The pneumatic conveyor has only one moving part—the fan—the whole system being practically trouble-free in operation. When injection ceases the system is self-cleaning—a great advantage when frequent changes are made.

Lay-out In almost every case, a bulk storage installation will consist of:

1. A building to house the installation.
2. A receiving hopper or pit.
3. A grain drier or dresser and pre-cleaner.
4. Bins to hold the grain.
5. A conveying system to move the grain.
6. A power unit or units to drive the conveying mechanism.
7. A point where the grain can be sacked off.
8. Sack storage space.

The lay-out of the installation should permit speedy discharge from vehicles bringing in grain; the wet grain pit should be sited to allow vehicles to draw over or pass it without turning or backing; the capacity of the pit should be matched to the size of the combine and the type of vehicle used for transporting grain and the throughput of the conveying system. Water is often troublesome when an excavation is made for the pit. Temporary methods are seldom successful and often prove the most costly in the long run. If water is present adequate steps should be taken to keep it out; this can best be achieved by a lining of two $\frac{3}{8}$-inch thick layers of asphalt.

The number of bins installed will depend on the total capacity and the type of building. A large number of small bins is preferable to a small number of large bins; if the latter is unavoidable, greater flexibility can be obtained by partitioning large bins.

Arrangements must be made for conveying the grain from the receiving pit to the drier or dresser and thence to the storage bins. From time to time it will be necessary to turn over the grain and to bring it from the bin for sacking. The sacking-off point should be as close as possible to the sack storage space and the loading platform, which, if possible, should be raised.

A power-driven pre-cleaner and dresser are an integral part of a bulk grain storage installation. It should be large enough for the size of the installation, preferably with a throughput of not less than 2 tons per hour. If the dresser can be raised sufficiently, the sacking-off point can be placed immediately below it. Given sufficient height, it is an advantage to provide a hopper between the outlet from the dresser and the sacking-off spouts. This reservoir will provide flexibility and possibly reduce the labour required for sacking-up grain.

LOSSES AND GAINS OF AGRICULTURAL LAND IN ENGLAND AND WALES

THE extent to which a more or less limited total area of agricultural land is being depleted from year to year by the inroads of building development, the needs of the Service Departments, and so on, has aroused a good deal of attention. This article is concerned with the statistical basis for estimating the extent of those losses. It is commonly assumed that the Ministry, which obtains returns of crops and grass from occupiers and publishes annually the total area of these and of rough grazings, must be in a position to state the year-to-year changes accurately. Such estimates have indeed appeared in the Reports of the Barlow Commission and Scott Committee, and have been quoted in Parliamentary Debates; and they have also been accompanied by estimates of agricultural land lost to particular alternative uses, such as housing.

Actually the accurate estimation of the amount of land lost to agriculture is a difficult matter, not only in England and Wales, but in any country of the world. In this country the areas recorded do not cover all the land which could reasonably be regarded as agricultural, and the area not included is capable of varying so much as to obscure the year-to-year changes in the part covered by the annual returns.

It may be of some interest to outline the main reasons for the omission of some part of the total agricultural area.

Scope of Official Statistics First, the statistics have as their main object the estimation of crop and livestock production: to account for the total agricultural area is only a secondary purpose. Thus these statistics have not hitherto extended to estimating that part of the area of agricultural holdings which consists neither of arable crops nor of permanent grass and rough grazing land. That is to say, the Ministry's returns do not cover the area of copses, spinneys and shelter belts; of land occupied by farmhouse and farm buildings; that under farm roads and yards; ponds; the occupier's flower garden or lawns; patches of land not used for any agricultural purposes. For some of these items, statistical inquiries from occupiers would not be covered by existing statutory powers which relate to land "used for agriculture" in a strict legal sense.

On the other hand, returns of land taken from agriculture by other Departments, such as the Ministry of Transport, would no doubt include these non-agricultural areas, and for this reason would fail to agree with the Agricultural Department's estimate of loss for the same land.

Secondly, the statistics of acreages have not, during the past fifty years, covered pieces of agricultural land of one acre or less. Thirdly, they do not, for obvious reasons, cover land which for one reason or another is not at the time known to the officer collecting the returns to be used for agricultural purposes, though this area is believed to be much smaller now than formerly.

Whether or not the sum total of the excluded areas is statistically significant depends on the use to be made of the statistics. There is no reason to think that their inclusion would exert any appreciable effect on the Department's estimates of crop or livestock production. Nevertheless in the particular context of annual changes in the total agricultural area these matters are important for the reason that the non-included areas may fluctuate considerably from year to year.

The leading instance under this head was the addition to the returns of some 250,000 acres in 1941, the year in which feedingstuffs rationing was introduced. Many occupiers of holdings who were not furnishing returns because they were not on the collector's list of addresses then found it desirable to draw the attention of the Ministry's officer to the omission and to ask for forms of return to be sent to them. Similar but smaller changes also affected 1942 and 1943. It is evident that changes of the magnitude of 250,000 acres in a year are capable of masking the true change in the area of agricultural land, and in fact in 1940-41 converted a probable true loss into an apparent gain.

For all these reasons the year-to-year changes in the total area recorded by the Ministry's returns can be taken only as a very rough guide to the net annual loss of agricultural land in any given year and, on occasion, may even be misleading. Averages covering a series of years will smooth out minor fluctuations but will do no more than minimize the effect of a major fluctuation such as occurred in 1941.

Tracing Changes in Land Use It is necessary, therefore, to investigate as far as possible the reasons for the various changes of acreage, but other points of difficulty then arise. These derive from the fact that every year there are no fewer than 80,000 holdings which show changes in acreage. To trace the reasons for all these changes would involve a great deal of labour, even if there were no difficulty in discovering the facts on first inquiry; but, in addition, the reasons for the change may by no means be immediately apparent.

When returns fail to arrive from any occupier on the list the local officer responsible for the collection of the returns makes inquiries to see whether the land has changed hands and has ceased to be used for agricultural purposes. In the latter event the local officer is expected to do his best to ascertain how the land is to be used in future. Similar inquiries have to be made when the acreage returned by any occupier is reduced. By summarizing the explanations obtained in this way, it is possible to arrive at some approximate indications of the gross losses of agricultural land in the course of the year and the main reasons for those losses.

There are, however, " gains " every year which must be set against these losses. Not only is land returned from the Service Departments to agricultural use—in which case the change usually comes to notice immediately—but derelict land may be reclaimed, or land previously taken for building development may be brought back into agricultural use. It is physically impossible for the Ministry's officers to keep track of all such land returning to agriculture, and often it is only after the land has been in agricultural use for some years that the occupier is asked to make a return. In these circumstances it would involve a disproportionate expenditure of time and labour to link up the new return with the earlier deletion, and commonly it has sufficed that an explanation "not returned last year" has been accepted. On the "gains" side, therefore, there is an element of uncertainty in respect of a not inconsiderable proportion of the total, and the gains cannot be matched against the corresponding losses. Thus during 1939-40 to 1944-45 the recorded average loss to building was 24,300 acres annually, and recoveries from building 9,100 acres annually. The latter figure, however, is certainly a considerable underestimate ; much of the recovery under the heading "previous use uncertain" (other than land previously escaping enumeration) is undoubtedly due to the return to agricultural use of land taken for building development some years previously, and not built on.

Estimates of Land lost and gained since 1927

The following Table presents the available data, subject to the reservations discussed above.

Losses and Gains of Agricultural Land in England and Wales

	Average of 12 Years 1927-28 to 1938-39 *thousand acres*	Average of 6 Years 1939-40 to 1944-45 *thousand acres*	Average of 3 Years 1945-46 to 1947-48 *thousand acres*
I. GROSS LOSSES			
Building Development	47.5	24.3	38.6
Allotments	2.5	3.7	2.4
Sports Grounds	11.0	3.7	9.7
Waste	7.2	5.9	1.6
Woodlands	18.6	18.9	10.1
Forestry Commission	—	6.1	8.7
Governments Departments	8.8	123.6	14.0
TOTAL	95.6	186.2	85.1
II. RECOVERIES			
Building (sites vacated)		9.1	2.6
Allotments		1.3	.5
Sports Grounds		8.2	1.0
Waste	17.1	11.5	1.8
Woodland		3.9	3.0
Forestry Commission		2.2	1.4
Government Departments		22.2	63.7
TOTAL	17.1	58.4	74.0
Previous use uncertain	14.8	71.1	13.7
Grand Total	31.9	129.5	87.7

cont'd from previous page

	Average of 12 Years 1927-28 to 1938-39 *thousand acres*	Average of 6 Years 1939-40 to 1944-45 *thousand acres*	Average of 3 Years 1945-46 to 1947-48 *thousand acres*
III. Net change in the agricultural area of crops, grass and rough grazing in sole occupation, i.e., difference between I and II (increase + decrease —)	—63.7	—56.7	+ 2.6

In the twelve years prior to the war there was an average annual gross loss of rather less than 100,000 acres, of which approximately one half was reported as being intended for building development. Recoveries averaged 32,000 acres, and the net decrease in the area covered by the agricultural returns (excluding rough land grazed in common) was about 64,000 acres. In those years the local officers were not required to attempt to ascertain the previous use of land reverting to agricultural use, beyond reporting where it was not so used in the preceding year. During the six years ended 1944-45 the gross losses practically doubled, mainly by reason of the large demands of the Service Departments for airfields, training grounds, etc. Recoveries also increased, and the remarkably high figure of 71,000 acres under the heading " previous use uncertain " was due in large part to the operation of war-time controls and measures such as the feedingstuffs rationing scheme already referred to ; the increase in the average rate of recovery represents not so much new areas brought into agriculture as the recording of agricultural land that had previously escaped enumeration. On balance, however, recoveries were still less than gross losses, and over the six years the average decrease in the recorded agricultural area was approximately 57,000 acres.

During the past three years annual gross losses have dropped by over 100,000 acres from the war-time average, and the Table shows clearly that this is the result of diminished demands by Government Departments generally. The area of land intended for building development as well as for sports grounds has increased again, but these increases have been offset in other directions. The annual rate of loss, apart from requirements of the Forestry Commission and Government Departments, has been less than in the pre-war period. Recoveries have also fallen away in total because of a return to normality under the heading " previous use uncertain," although recoveries from known sources increased because of the release of land by Government Departments. On balance, there was a trifling increase in the agricultural area.

FOUL BROOD DISEASE OF BEES ORDER, 1942

SUMMARY REPORT, 1948

FOR the fifth successive year the returns from the County Agricultural Executive Committees in England and Wales show an increase in the number of apiaries and colonies of bees inspected by Appointed Officers under the Foul Brood Disease of Bees Order, 1942. 14,500 apiaries, containing a total of 61,600 colonies, were examined during 1948. Foul Brood was found in 940 apiaries and 1,880 colonies ; it was also found in three "wild" colonies. Two beekeepers were prosecuted for failing to comply with notices, served under the Order, to destroy infected colonies.

The position in 1948 in relation to 1944-47 for England and Wales as a whole was as follows:

	1944	1945	1946	1947	1948
Apiaries visited	6,600	9,300	10,900	12,400	14,500
No. in which Foul Brood was found:					
American F.B.	995	930	795	845	919
European F.B.	20	11	24	43	21
TOTAL	1,015	941	819	888	940
PERCENTAGE OF INFECTED APIARIES ..	15.4	10.1	7.5	7.2	6.5
Colonies examined	26,500	35,200	45,200	52,000	61,600
No. in which Foul Brood was found:					
American F.B.	1,802	1,602	1,357	1,361	1,840
European F.B.	43	30	52	145	40
TOTAL	1,845	1,632	1,409	1,506	1,880
PERCENTAGE OF INFECTED COLONIES ..	6.9	4.6	3.1	2.9	3.0

The number of Appointed Officers engaged during 1948 in the work of carrying out inspections under the Order was 588. This total consists largely of beekeepers who have volunteered for local duties in their spare time, but a number of officers have now been appointed to work on a full-time basis for the period of the active beekeeping season. The desirability of retaining an adequate panel of experienced beekeepers for local work has, however, been stressed whenever proposals for the appointment of full-time officers have been put forward, since experience has shown that the part-time worker with a good knowledge of local conditions makes an important contribution to the smooth working of the county organization. The inspection of over 60,000 colonies, or about one-seventh of the total number of colonies in England and Wales, in one season is a very creditable demonstration of the interest in the campaign against Foul Brood which has been aroused among beekeepers since the introduction of the Order.

American Foul Brood The increase in the scale of inspections in 1948 was accompanied by an increase in the number of apiaries in which American Foul Brood was discovered—919 as against 845 in 1947. An intensification of the search for Foul Brood in Gloucestershire and Kent followed the appointment in these two counties of full-time County Beekeeping Instructors, who were seconded to their respective Agricultural Executive Committees for work under the Order. Many outbreaks of American Foul Brood came to light, involving 468 colonies—241 in Gloucestershire and 227 in Kent, compared with 3 and 18 respectively in 1947. In addition, numbers of derelict hives containing diseased combs were found. The outbreaks in these two counties account almost entirely for the increase in the number of cases of American Foul Brood recorded during the year; in both Gloucestershire and Kent, however, relatively little had been done in previous years to control Foul Brood. In some other counties the scale of inspections has been maintained at a consistently high level for the past three, four, or five years; and it is in these counties,* which altogether contain approximately 45 per cent of the total number of colonies in England and Wales, that the most consistent efforts have been made to check the spread of the disease. The incidence of Foul Brood per 100 colonies examined, calculated year by year for the combined territory represented by these active counties, is as follows:

1944	1945	1946	1947	1948
7.1	4.3	2.9	2.7	2.1

* Bedfordshire, Berkshire, Buckinghamshire, Cardiganshire, Cornwall, Cumberland, Devon, Dorset, Essex, Hampshire, Middlesex, Norfolk, Somerset, Surrey, Warwickshire, Wiltshire, Yorkshire (North Riding) and Yorkshire (West Riding).

These figures give the clearest available indication of the cumulative effect of a persistent policy of eliminating Foul Brood wherever it is found, combined with regular inspections and follow-up visits in the infected areas. Any slackening of effort now would very soon undo the good work that has been done in the past, and it is hoped that in counties such as Gloucestershire and Kent which have only recently made a real effort to tackle the disease systematically—and in others where the effort has yet to be made—the campaign will be stimulated by a realization of what has been achieved elsewhere.

European Foul Brood The number of cases of European Foul Brood reached a peak in 1947 (145 colonies in 43 apiaries) following the 1946 outbreak in Wiltshire,* but in 1948 only 40 cases in 21 apiaries were reported. These included four cases in one locality of Essex—the first recorded in this county: one was discovered in a colony established from a stray swarm; further search led to the discovery of two more cases, and finally to the fourth in the apiary of a beekeeper who brought two colonies from the infected source in Wiltshire in 1946. There is no evidence of any large-scale spread of European Foul Brood as a result of the 1946 outbreak, despite the large number of colonies which were sold to various parts of the country, though the extent to which infection may have spread in the neighbourhood of the apiary sites in Wiltshire previously occupied by the diseased bees has not yet been fully investigated.

Sulphonamide Treatment Since the previous report was published on the use of sulphonamides against American Foul Brood,† further trials have been carried out on colonies selected for special treatment. Three methods of giving the drug to infected colonies have now been tried:

(1) Feeding syrup containing the drug without removal of any of the diseased brood or contaminated honey;
(2) Feeding syrup containing the drug following the transfer of the bees to clean comb foundation in a clean hive, all the brood and combs being destroyed by fire; and
(3) Spraying the combs with a solution of the drug in alcohol.

The first method, though effective in most of the trials where it was applied, failed to clean up the disease in two instances, even after prolonged treatment extending over several months, and in two of the colonies which were apparently treated effectively in 1946 a recurrence of the disease was reported—in one case later in the same year, and in the other case in 1948. Similar recurrences have frequently been reported from America following the application of this method. The well-known "shaking" method, of which method (2) is a modification, has always been regarded as a difficult operation requiring great care if the spread of disease is to be avoided. Experience in this series of trials has confirmed this view; two of the trials had to be abandoned because the bees swarmed out of their new hives shortly after the shaking and were lost. Method (3), applied to two trial colonies in 1948, eliminated all visible signs of disease after three sprayings during a period of six weeks; these colonies will be kept under observation in 1949. Here again, however, the combs must be shaken to free them from bees before spraying, and there would be a risk of robbing if the operation were carried out carelessly, especially if done late in the season after the main nectar flow.

---

* Summary Report, 1946-47. *Agriculture* (May, 1948), 88.

† MILNE, P. S. Sulphonamide Treatment of American Foul Brood. *Agriculture* (May, 1947), 82.

None of these methods can, therefore, be regarded as a safe alternative to burning the bees and combs. Also, it is now known that sulphonamides have no beneficial effect on *European* Foul Brood. Consequently, the policy of destroying all cases of Foul Brood (American or European) dealt with under the Order is being maintained. The destruction extends, however, only to those colonies in which the presence of Foul Brood is confirmed following a laboratory examination of a sample comb ; healthy colonies in the same apiary are not subject to destruction. No compensation is payable from official sources for colonies destroyed, but beekeepers are reminded that many beekeepers' associations can offer compensation to their members either through the scheme operated by Bee Diseases Insurance, Ltd.* or from funds available within the local or county organization.

FARMING AFFAIRS

Linseed Harvesting, 1948 : West Riding Experience Success in linseed harvesting depends largely on the uniformity of the crop; it is therefore essential to prepare a fine, firm seedbed and to drill the seed evenly and early, using one of the newer varieties such as Redwing, Royal or Bison, which ripen more evenly and the seed heads of which do not shatter.

Our experience with linseed in the West Riding last year proved that, provided the cutter-bar is in good condition, with the knife and ledger plates sharp, and with the clips and wearing plates adjusted correctly, the binder will deal with linseed quite satisfactorily. In most cases ground-wheel drive binders have been used, but it is, of course, preferable to use a power-driven machine, because under difficult conditions the forward speed of the binder may then be lowered without changing knife speed.

It is important that the binder should be set to tie as small a sheaf as possible, since it permits easier separation when the sheaves are ejected from the binder. Further, small sheaves dry out more easily, and to assist drying still further the sheaves should be set up only four per stook.

It has been found that the plain section knife is more efficient than the serrated-edge knife, provided it is kept very sharp. The serrated knife does not give a clean cut, and consequently breaks the fibre, which in turn causes the knife to jam, particularly if there is any wear or play on the cutter-bar.

Linseed has been cut with a mower in a few instances, and as the knife speed on a mower is higher than a binder, cutting presents little or no difficulty ; but it is essential that the cut crop should not be run over, since the slightest pressure will cause shelling. One way of overcoming this difficulty is to fit two swath-boards to the mower.

Direct combining of linseed should not be generally adopted, as it is rarely easy and has the following disadvantages : (1) Loss of chaff which is good feed ; (2) Loss of seed may be heavy ; and (3) Difficulties in drying the seed.

Some growers have found that the knife speed is not fast enough on combines, and this has led to innumerable stoppages ; one farmer I know had to abandon combining and cut with a mower. Linseed may be combined direct or from the windrow ; opinions are generally divided as to which is the better method, but each has its advantages. One of the chief advantages of

* C. P. Abbott. The Story of Bee Diseases Insurance. *Agriculture* (April, 1949), 21.

direct combining is the saving in labour. On the other hand, windrowing is useful sometimes to dry out weeds in a ripe crop. Apart from specially designed windrowers, the binder can be used with part of the tying mechanism removed. This method puts the crop into a uniform row well clear of the tractor next time round. The linseed should feed into the drum evenly from the windrow ; it is therefore essential to have an efficient pick-up attachment fitted.

To sum up, the method to be recommended for harvesting linseed is to cut with a binder, stook, stack and thresh with a standard machine. A combine harvester in the hands of an experienced operator may do a fair job, but is not generally recommended.

G. Crabtree.

Nature Month by Month—August We have reached the crown of the year, and summer has noticeably waned. The corn harvest is under way, and many and various will be the creatures that bolt from sanctuary in the "last bit". Reaping has laid bare the stale secrets of bird and beast and insect ; the empty waxen shells of a bumble-bee's nest in an old mouse-hole ; the bigger hole where, unsuspected in the spring, a litter of weasels was born and reared ; the abandoned nest of a skylark from which the young have long since gone.

In the woods the tits are flocking, some in family parties and some in mixed gatherings of two or three species. One sees them travelling from tree to tree, vociferous and busy in their search for insects. It is good to find the dainty long-tailed tits in something like their old numbers ; they seem to have recovered from the great blizzard of three years back.

The adult cuckoos have gone overseas, but the young birds will be with us for a month or two longer. One remembers, as recently as last month, the shrill, querulous voice of a young cuckoo in the nest of a pair of small birds whose long day was occupied in feeding their insatiable foster-child. It is no wonder that the death-rate among young cuckoos is so high. Never was there a noisier young bird, nor one that so persistently advertised its presence to the world of predators. Bird song is almost wholly absent, now. Yesterday, the only bird that I heard singing was a yellowhammer, complaining, as always, that his "little bit of bread" had "no cheese".

There is more water in the river, now. A week or two ago, before the rain came, there were a dozen big peal in the pool below the weir, waiting for a friendly freshet. All have gone on. The other day I found a three-pounder, dead upon the bank, that had fallen prey to an otter, which in the way of otters had taken a bite or two from the fish's back near the head and left the rest. I have never known an otter to return to a kill. In the shallow reach above the weir there stands a heron, stiff and motionless, seemingly asleep but very wide awake, bill down, eyes steady on the rippling water.

Up on the Moor, in bare, stony places, adders bask in the sun. There are more of them, I think, than I have seen in any other year. Also, every big, sun-baked stone seems to have its lizard, beady-eyed and watchful, ready in spite of its apparent lethargy to move like lightning if danger should threaten.

This month the heather will be in bloom, and then we shall have sunsets the like of which are hard to find elsewhere. Often, in late summer, I have watched the sun go down beyond the Moor, when all the world seemed filled with a purple glow.

F.H.L.

Increase in Pig Rations : Further Details Below are given further particulars of the increased rations for commercial pig production announced by the Minister of Agriculture and Fisheries on May 19. (See p. 130 of the June issue of this JOURNAL.)

1. *Bonus Rations.* With the period commencing September 1 the rate is increased to 3 cwt. per 160 lb. (8 score) of pigmeat delivered to slaughter-houses and bacon factories in the previous four months. Producers who obtain regular rations for pigs from their County Agricultural Executive Committees will receive a bonus application form from their Committee in due course. Others can obtain these forms on application to their Committee.

2. *Farrowing Sow Allowance.* The rate is increased from 8 cwt to 9 cwt. for eligible sows due to farrow on or after July 1, 1949. From September 1, 1949 the allowance will consist of 3 cwt. of a new National Pig Starter food, with the remaining 6 cwt. in ordinary cereal and protein. This new Pig Starter food has been specially designed to provide for the needs of young pigs and contains a higher minimum proportion of protein than existing pig foods. Producers will get information on the best method of using the food and when sending in their application forms will have an opportunity, if they prefer, to ask for the whole 9 cwt. in ordinary cereal and protein coupons.

3. *Basic Issues.* For the period September to December, 1949, as an interim measure, basic rations for *pigs* will be given for up to 22½ per cent (9/40ths) of the basic registered pig numbers, at the rate of 1 cwt. per pig per month, after making the present acreage deduction of 1 cwt. per 64 acres of the holding. The increase in the ration given to occupiers of combined "pig and poultry holdings" will be provisional, as a possible method of bringing the rations for these holdings into line with present stock numbers is under discussion. Occupiers of such holdings must not assume, therefore, that after the end of 1949 they will continue to get exactly the same increase as for the period September-December, 1949. Poultry rations will be at the winter rate of 1 cwt. for 20 birds per month for one-fifth of the registered numbers, less the usual acreage deduction.

4. *Extended Scheme.* From September 1, 1949, the new specified numbers for pigs for which rations can be allowed are as follows :

ACREAGE OF HOLDING (excluding rough grazing)	SPECIFIED NUMBERS OF PIGS	MONTHLY RATION *cwts.*
Over 1 and not over 5	4 (including not more than 1 sow)	2
,, 5 ,, ,, ,, 20	8 (,, ,, ,, ,, 2 sows)	4
,, 20 ,, ,, ,, 50	12 (,, ,, ,, ,, 2 ,,)	6
,, 50 ,, ,, ,, 150	24 (,, ,, ,, ,, 4 ,,)	12
,, 150 ,, ,, ,, 300	48 (,, ,, ,, ,, 6 ,,)	24
,, 300	72 (,, ,, ,, ,, 8 ,,)	36

Up to 5 acres there is no change, but over 5 acres the numbers of pigs for which half rations can be obtained is considerably increased. A number of pig-keepers receiving basic rations will therefore benefit by transferring to the extended scheme. In England, anyone in doubt on this point should ask the County Committee for advice on the advantages or otherwise of such a transfer, and all intending entrants to the extended scheme should apply to their Committee as soon as possible. In Scotland, queries and application forms should be sent to the Department of Agriculture for Scotland, Government Buildings, Bankhead Avenue, Sighthill, Edinburgh, 11.

Cleaning Combine-Harvested Grain The wise organization of combine harvesting requires that cutting shall be delayed until the crop is fully ripe. It also calls for cutting the crop only in the driest part of the day. These two factors usually mean that when the combine is at work it must be operated at as high a cutting rate as possible, which in turn may lead to something less than a perfectly clean sample.

In some seasons it has been possible to sell even dirty grain straight from the combine. But this is becoming more difficult; grain with too much chaff and broken seeds and rubbish in it may not find a good market in future. Moreover, the increase in the number of combine harvesters throughout the country has intensified the need for storing grain, if only for a short period, in the farm buildings. Any greenstuff left in the grain increases storage difficulties.

Grain drying plants have cleaners incorporated in their mechanism. Some driers have both a pre-cleaner and a final dresser. The pre-cleaner, which often consists of a simple winnower with a sieve to separate coarse rubbish, removes material that might injure the drier, interfere with the passage of air through the grain, or taint the grain during drying. The final dresser has a set of riddles, rotary screens or indented cylinders, to clean and grade the grain. Therefore, if the grain is dried, the cleaning is looked after automatically.

The aim nowadays, however, is to plan the combining so that as little as possible of the crop needs to be dried at all. Nevertheless it is often a good thing to run the drying mechanism without the heating apparatus, so that, even when tests have shown that the moisture content is low enough to make artificial drying unnecessary, the grain can pass through the machine. This not only cleans the grain but also evens out the moisture content, by dispersing any small damp patches into the bulk of the grain.

Many farmers have no drier at all on the premises, and rely in an emergency on communal drying facilities, but it is well worth while in these cases to fix up some simple cleaning apparatus. Many farmers will have one of the old wooden winnowing and dressing machines that were used thirty years ago. Many of these machines, which combined winnowing, riddling and screening, were hand-turned, and their rated capacity was about 40 bushels an hour. In thinking of capacities, however, it must be remembered that the output varies considerably with the state of the grain passing through it. Unusually dirty grain may have to go through the machine at only half of the rated throughput speed. Nevertheless these old hand-turned machines can be relied on to clean half a ton of grain in an hour. Hand-turning hour after hour is an irksome job, and it is well worth while to rig up a small engine to drive the machine. Larger machines were made and these can sometimes be bought secondhand. They need a 2 or 3 h.p. engine and they are rated at 100 bushels an hour.

Cleaners of this kind are still made by several manufacturers, and, in addition, several new kinds of machines are now available. These range from miniature winnowing and sieving machines for dealing with 10 bushels of wheat an hour, up to cleaning and grading machines dealing with 4 tons of wheat an hour.

It is well to fit it up in the barn in such a way that handling of the grain before and after cleaning will be as easy as possible. For example, it may be possible to construct some kind of receiving hopper and elevator to deliver the grain into the winnowing machine, and to site the machine so that the sacking-off spouts are conveniently placed. It is often a good plan to have the weighing machine sunk into the floor, so that the platform is at ground level. If fitting up involves the use of chutes it should be remembered that they should be wider at the bottom than at the top, and any bends in them should be arranged in such a way as not to present corners where grain may pile up and cause a blockage.

One other way of cleaning grain should be mentioned. If an ordinary stationary threshing machine is available on the farm, the combined grain can be passed through it to take advantage of the cleaning and grading mechanism.

Printed in Great Britain under the authority of HIS MAJESTY'S STATIONERY OFFICE by C. Nicholls & Company Ltd., The Philips Park Press, Manchester, London and Reading.

Please mention the JOURNAL *when corresponding with Advertisers*

Please mention the JOURNAL *when corresponding with Advertisers*

Facilities

for

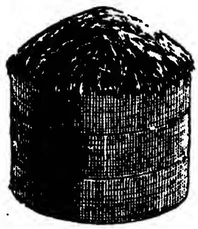
Farming?

Midland Bank

Limited

SISALKRAFT
TRADE MARK

AIDS FOR FARMERS



SISALKRAFT SILOS

The Temporary Silo with the permanent reputation

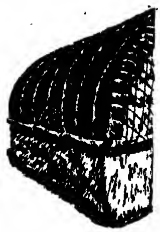
REDUCTION IN PRICES THIS SEASON!

No. 1 Size: Capacity 16-18 tons (approx.). **£11-5-0 complete**

No. 2 Size: Capacity 40-45 tons (approx.) **£16-15-0 complete**

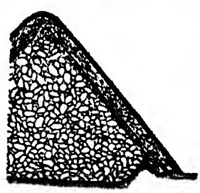
These well-tried Silos (over 20,000 in the U.K. alone) possess the following advantages. PORTABILITY, LOW COST, NO HEAVY PARTS, SAFE AND SIMPLE TO ERECT—anywhere.

HAY STACK COVERING WITH SISALKRAFT



Use SISALKRAFT and STACK NETS and SAVE PRICELESS LABOUR AND TIME. Two unskilled workers easily cover a normal-sized stack in half-a-day.

CLAMP LINING WITH SISALKRAFT



The SISALKRAFT method of lining potato, beet and other clamps has been proven by countrywide tests including some of the wettest areas in Britain. Results have shewn—in POTATO CLAMPS ..... Negligible losses—in BEET CLAMPS ..... No Observable Waste. SISALKRAFT eliminates the bugbear of handling the usual forbidding quantities of earth. SAVES TIME—SAVES MONEY. Waterproof and virtually frostproof.

Write now for prices and details of Agricultural Uses mentioning this advertisement.

Sole Distributors for British Sisalkraft Ltd.

J. H. SANKEY & SON, LTD.

ALDWYCH HOUSE, ALDWYCH, LONDON, W.C.2

Phone: HOLborn 6949. Grams: Brickwork, Estrand, London.

Hop Yields Increased by PESTOX III

Pestox III, the new systemic insecticide is absorbed by the plant and renders it toxic to Hop Aphis. Beneficial insects are unharmed.

The protection given by one spraying lasts two or three weeks.

Pestox III is not toxic to the Ladybird Larvæ and Hoverfly Larvæ.

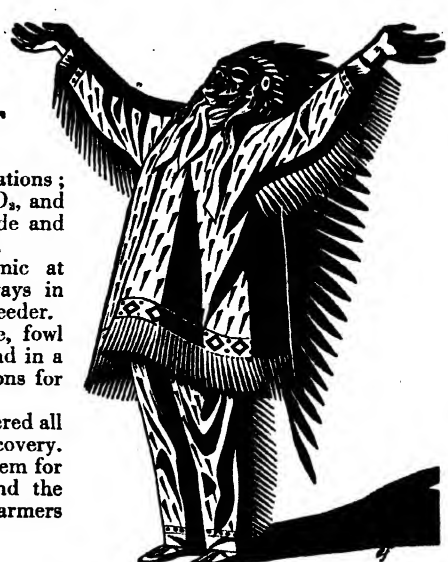
Our experience shows that more luxuriant growth and much increased yield result from the use of Pestox III.

Pestox III is available only as a Contract Spraying Service.

PEST CONTROL (U.K.) LTD.

CAMBRIDGE Telephone: Harston 312/6

The Rainmaker



To bring rain, Red Indians used incantations; modern scientists spray clouds with CO_2, and they have also discovered that silver iodide and lead iodide could be used to produce rain.

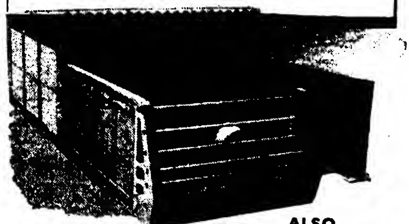
For this purpose iodine is uneconomic at present, but there are many practical ways in which it can help the farmer and stockbreeder.

Iodine is used in treating animal goitre, fowl paralysis, coryza, mastitis and infertility and in a surprisingly wide range of other applications for agriculture, chemistry and medicine.

The Iodine Educational Bureau has gathered all information existing on iodine since its discovery. Possibly iodine might help to solve a problem for you. The Bureau offers its knowledge and the services of its consultants without charge to farmers and voluntary practitioners.

Iodine Educational Bureau 26 STONE HOUSE, BISHOPSGATE, E.C.2


SAN IZAL



Bob Hawling uses the Ferguson earth scoop to shift soil from an irrigation ditch.

Floating FARMLAND

A Ferguson tractor turns a Somerset wilderness into land fit to support a pedigree herd of Guernseys

"The soil may be peat, but it floats on water," farmers warned Dr. William Plant when, two years ago, he bought Tickenham Court Farm, Clevedon, Somerset, and 110 acres of unpromising marginal land. Nevertheless, Dr. Plant announced his intention of establishing a pedigree herd of Guernseys and supporting them on this land that flooded for six to eight months every year.

Much of the land was deep peat soil on blue clay sub-soil, but without the usual acidity of peat thanks to the run-off from surrounding limestone ranges. It had the promise of richness, but could that richness be brought to light? Dr. Plant thought it could. He bought a Ferguson tractor (£325), a mower (£75), a 16" plough (£28) and an earth scoop (£12.10s.).

"The land simply was not negotiable except with a Ferguson," the Doctor tells us now. "And only a Ferguson with its mower could be used to cut the rushes successfully. They have to be cut three times a year and an ordinary trailer mower could not start early enough."

The rushes were cut, the rich soil was ploughed and arable crops were planted. Beans, linseed and oats thrived and rich, high-protein grass was provided for the yearlings which were imported from Guernsey as the nucleus of the herd in 1946. The first five heifers lactation was 840 gallons in 305 days and butterfat content of the milk was 4.7 per cent. The "floating farmland" had become a good deal more than self-supporting.

The deep-digger 16" Ferguson plough goes to work on land which two years ago farmers declared unworkable—until they saw it being worked by the Ferguson.

One Ferguson in its day plays many parts on Dr. Plant's farm. In the courtyard before the 14th century buildings of The Court, Bob Hawling gets to work with the wood saw.

FARM BETTER, FARM FASTER WITH FERGUSON

Ask your Ferguson Dealer for a demonstration on your farm.

Ferguson Tractors are manufactured by the Standard Motor Co. Ltd., for Harry Ferguson Ltd., Coventry.

S 27A

Please mention the JOURNAL *when corresponding with Advertisers*

Agriculture

PUBLISHED 6^{d} MONTHLY

Please mention the JOURNAL *when corresponding with Advertisers*

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

Editorial Offices: St. Andrew's Place, Regent's Park, N.W.1 (*Phone : WELbeck 7711*)

VOL. LVI — No. 6 — SEPTEMBER 1949

¶ *Provided that the source is acknowledged in each instance, such articles and notes as are published in this Journal without any specific reservation regarding copyright may be reproduced in any registered newspaper or public periodical without special permission. The Ministry does not accept responsibility for statements made, or views expressed, in signed contributions to this Journal or in those reproduced from another source.*

¶ *Further, the Ministry does not accept responsibility for any of the private and trade advertisements included in this publication.*

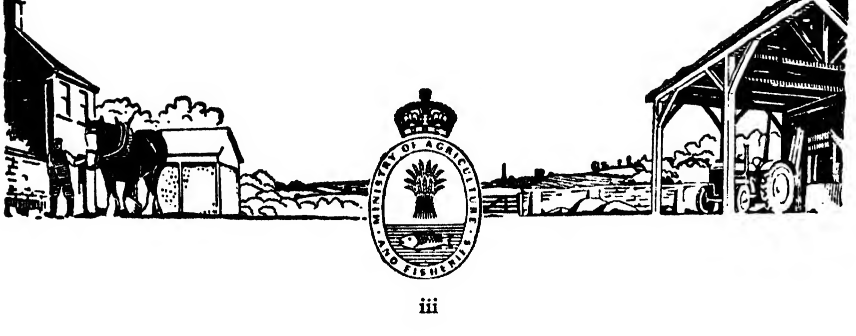
¶ *All communications respecting advertising in the Journal should be addressed to the Advertisement Contractors, Aldridge Press, Ltd., 15 Charterhouse Street, London, E.C.1. Telephone : Holborn 8655.*

Contents

Page

Cover Photograph

EXMOOR LANDSCAPE .. .. .. J. D. U. WARD



AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LVI | No. 6 | SEPTEMBER 1949

SOME ECONOMIC ASPECTS OF BULLOCK-FEEDING

W. HARWOOD LONG, M.A.

Department of Agriculture, University of Leeds

ROAST beef has for long been regarded almost as a national emblem, and in spite of the pre-war invasion of Argentine chilled beef and the impeccable reputation of Scotch longsides, there has always been something typically English about beef, whether grazing on the pastures in the summer, feeding in foldyards in the winter, or awaiting the grace at table. But nowadays there are many fewer bullocks at grass than there used to be, the numbers fattened in the winter have decreased tragically, and no board is likely to groan under the present-day ration of meat.

Much has been heard of the meat shortage from the consumer's point of view, and in its attempts to overcome the present critical shortage the Government has just offered a substantial increase in price to the Argentine for imported beef. Quite recently, too, it raised the price of home-fed fat cattle by 4s. 6d. per cwt. live weight (following a much larger increase in 1947), and it also pays a subsidy of £4 a head for steer calves and £3 a head for heifer calves suitable for rearing. The purpose of this article is to discuss some of the features of beef production from the home producer's point of view.

Feeding cattle can be divided into two classes—grass fattened and yard fattened. This division is useful, although, as will be shown later, the two methods of feeding sometimes merge.

It is fairly easy to write about grazing cattle, though considerable skill is necessary to practise it successfully. Costs depend largely on the rent of pasture, and where no artificial food is fed they can vary from £2 to £4 10s. per beast for a grazing period of 20 weeks or so. Success depends on the management of the grass and on the margin between the cost of the store when it is bought and the price of the fat beast. In the old days the grazier was able to demonstrate his skill at both ends, but nowadays if he does not buy his stores well his chances of a profit rest entirely on the success with which he manages his pastures and the beasts that graze them. Frequently the price per cwt. of stores in the spring is greater than the price of beef when the beast is sold fat. This jeopardizes the prospect of a profit, but it does not destroy it altogether, and usually grazing cattle should not lose money if the store price is not more than 6s. or 8s. per cwt. above the fat price. A study of grass feeding in Wales for three years during the war showed fat prices a shilling or so per cwt. higher than the prices the animals were bought at, and a profit of between £4 and £5 per head(1). More recently the Nottingham School of Agriculture has published a report on the results of grass feeding in 1946 and 1947. The fat price was some 3s. or 4s. per cwt.

above the store price, and profits of roughly £3–£4 per head were made in the two years([2]). In both these studies, however, nothing was allowed for overheads, and the real profit would, therefore, have been rather less than these figures. The present prices of store cattle make it difficult to believe that there will be any profit on grazing steers or maiden heifers bought this spring.

The problem with winter-fed beasts is less straightforward because seldom, particularly since 1939, have store cattle been fed in yards to make a direct profit. Financial returns computed by some universities and agricultural colleges are not encouraging. Most recent studies reveal direct losses of not less than £2 per beast, except in the years when an increase in the schedule of prices occurred during the feeding period.

The only economic justification for a branch of farming which shows continuous direct losses is any indirect advantage that may be associated with it—this with winter-fed cattle is the treading of the straw into farmyard manure. Often, too, the labour required by yarded cattle has no satisfactory alternative employment.

Experiments at Saxmundham on the value of the increased crops grown by using farmyard manure suggest that at 1943-44 prices the value of dung was 45s. per ton([3]). The quantity of dung made should be not less than one ton per beast per month, and on a five-month feeding period the value of the dung should usually, therefore, be enough at least to offset the cash loss on feeding.

Many feeders have, however, expressed their dissatisfaction with the direct losses they have recently sustained for their fat beasts, and they are seeking a way to convert their losses into profits.

The pre-war method of winter feeding was to buy store bullocks in the autumn and feed them for four or five months, largely on home-grown foods. The cattle were in the yards in the dead months of the year, when the considerable demand that they make on the labour staff could be met. By March the yards were empty, or almost empty, and the field work was not interfered with.

During and since the war less concentrates and more hay and straw have been fed than was usual when foods were more plentiful; the cattle have been done rather more slowly and the proportion which are out of the yards by the end of March is not nowadays so great as before the war.

Until this year the price of fat cattle did not begin to fall before the middle of June, and many feeders were able to vary the traditional method by running their cattle in good store condition through the winter and finishing them on the grass.

A report from King's College, Newcastle([4]), gives some revealing figures on this change in method. On 904 beasts that were wintered in 1946-47 and subsequently fattened on the grass, the net profit was £8 6s. per beast. This seems a very large profit when one remembers the losses which are the results of the alternative method. It is, in fact, too good to be generally true because it includes some beasts that were sold after August 25, 1947, when prices were increased by 14s. 4d. per cwt. or £8 12s. on a 12-cwt. beast. But if this is allowed for and the profit calculated on the basis of the price schedule before it was revised, the margin becomes 70s. per beast. Of course, the dung made during the winter in this way is not of the same quality as the cake-fed dung used to be, but it is possible to make up the difference by applying more artificial fertilizers.

Influence of Rearing Costs The actual fattening process takes up only some six months or so of the beast's life, whereas it is usually two or two and a half years old before fattening is begun. In point of time occupied, therefore, the rearing period is more

important than the fattening period, and the costs of rearing deserve at least as much discussion as the costs of fattening. These costs are complicated by the fact that there are many reasons besides direct profit that may decide a man to rear and/or fatten cattle, and often the method of management has to fit in with the requirements of the farm, instead of the system being moulded into the most profitable form. Here are nine reasons that may persuade a man to rear or fatten cattle :

1. For profit.
2. For manure.
3. To graze leys.
4. To improve hill land for sheep grazing.
5. To dispose of the culls from a dairy herd.
6. To utilize the by-products of arable land.
7. To utilize land that would otherwise be wasted.
8. For pleasure.
9. To satisfy the A.E.C.

Sometimes more than one of these apply at a time. Thus a Yorkshire Wolds farmer keeps a herd of beef cows which he crosses with a Hereford bull to utilize 80 acres of a dale that is too steep to plough. In the winter the cows and their progeny consume his arable by-products and make his straw into manure, while he has the pleasure of being able to look at a particularly pretty bunch of young stock when he walks down into his fold-yard in the winter or strolls round his farm on a summer evening. These beasts thus fulfil at least four functions.

Another Yorkshire farmer rears calves in order to save the high cost of Irish stores. They graze the leys he is introducing into his system as a means of lengthening the rotation to combat potato root eelworm.

Some farmers are still willing to lose money winter feeding cattle because of the manure and the satisfaction that a yard of well-bred bullocks will give. But they probably would not do it for one of these reasons alone.

Since cattle are kept for so many purposes, it is not difficult to understand that there are several methods of rearing. The chief are single suckling, multiple suckling, and bucket rearing.

Under single suckling the cows calve in the spring and during the seven months or so before weaning they live almost entirely on grass and consequently rear their offspring with the minimum expenditure on food and labour. By winter they are dry and are doing nothing beyond carrying next year's calves, and they can therefore still live cheaply ; many spend the winter outside, and on those farms where the cows are wintered in yards in arable districts the reason is generally to tread straw into manure. Single suckling is therefore an easy method of rearing calves, and cheap in every way except that the full year's cost of the cow has to be charged against one calf.

Under multiple suckling one cow should rear three or four calves and may be capable of rearing ten or a dozen in small batches. This system and bucket rearing require much more labour than single suckling ; moreover a good deal of skill is needed if the calves are to be kept in thriving condition. With winter milk at its present price there is a big temptation to sell it rather than feed it to calves, and it is easier to spare summer milk for calf rearing. On the other hand, arable farmers can usually spare labour for stock rearing more readily in winter than in summer.

It is difficult to generalize about rearing costs because they vary with the different methods adopted and from farm to farm. Where single suckling is undertaken on herds wintered outside entirely, the cost consists of grazing and whatever hand meat may be fed in the winter. Some farmers give nothing but hay (some nothing but straw) throughout the winter, and the

cost of the calf up to weaning at, say, seven months old appears to be as low as £7 10s. (plus overheads) in reasonably favourable conditions. If the cows are brought into yards for part of the winter, costs rise considerably. Where they are used to turn straw into dung it is, however, easy to overestimate the real cost of yarding the cows on an arable farm, for they may be the cheapest means of maintaining the fertility of the farm.

Data on calf-rearing costs at the present time are few and far between, and it is unwise to be dogmatic.

Probably most calves have cost at least £2 a month to rear by the time they are weaned. Their subsequent costs will then depend largely on whether they are weaned in spring or in autumn. The cost of summering a store beast is generally low, and will involve little more than the cost of pasture. In winter, costs are much higher for as long as the cattle are indoors, and will probably exceed £1 a month. Thus a beast at a year old may have cost £16 if born in the autumn and £20 or more if born in the spring. From then onwards until feeding is begun they should increase considerably in value at a comparatively low cost, since, except in hill districts, there will be no need to yard spring-born calves in their second winter, unless they are required to tread straw into muck.

Home-produced Beef in relation to World Supplies

A 12-cwt. bullock at the present time should be worth, say, £66 at three years old. This represents an average increase in value of £22 a year (disregarding its value at birth), and taking into account the very cheap middle period from weaning to the beginning of feeding, there should be a useful profit over the full period of its life. That cattlemen agree with this opinion is suggested by the increase in the numbers of young cattle being reared at the present time. A comparison of the numbers of steer and heifer calves at September 4, 1947, and 1948, respectively, shows a 36 per cent increase in the number of steer calves and an 18 per cent increase in heifers. (However, the actual increase in numbers of heifers, 180,000, was much greater than the increase in steers, 100,000).

On the other hand, it has to be remembered that these profits and increases in numbers are themselves largely the result of price increases and subsidies which make home-killed beef a very dear article, compared with the world price. Figures recently given in Parliament are that home-killed beef costs £136.08 per ton, compared with £68.25 to £79.75 per ton for imported beef, mainly Argentine frozen beef.* In addition, the home-rearer receives the subsidy on calves, the hill cattleman receives a special subsidy, and concentrated feedingstuffs, in spite of the recent reduction in their subsidy, are still below the price which they cost the Government.

But although these facts show that the price of home-produced beef is very much above the world price, there is no reason for the home farmer to fear competition in the immediate future. It has become only too painfully apparent in recent months that there is no more meat to be had than we are getting now, nor do the high prices of British beef divert consumption to something that is cheaper, because it is not the consumer who pays the difference in price. The consumer pays a price which is the same whether the beef is imported or home-produced, prime steer or cow—and the taxpayer pays the rest. From this it follows that, under the present system, there is no danger of an increase in prices to the producer being reflected in a reduced demand. (Nor is that very useful barometer, price, any longer able to measure the consumer's real demand for the commodity.)

* The recent agreement with the Argentine, however, raises the price of beef from that country to £96 per metric ton—10½d. per lb.

There seems no likelihood at present, then, of the high price of home-produced beef proving detrimental to the demand for it ; and in spite of its cost, farmers are being urged to produce more and more beef to meet the country's need. Yet however favourable the short-term outlook may be, it is impossible not to have some fears for the future when such a disparity between prices for home-grown and imported beef persists. We know the Government is financing a huge scheme for increasing beef production in Australia for this market, we know they are interesting themselves in the possibilities of developing cattle ranches in Africa, and we know the desire of France to become an exporter of meat to us. And although the favourable terms of trade which the Argentine now enjoys have enabled her to keep back for home consumption meat which before the war she would have sent to us, it is unlikely that she will be able to maintain her present favourable position if world supplies of food become more plentiful and prices of food fall in relation to other commodities.

If world supplies of meat improve and more becomes available, considerable pressure will almost certainly be exerted on the Government to buy as much as it can where it can be bought cheapest, and the home producer must be prepared to face the foreigner, if not on equal terms, at least on the basis of prices which show much less disparity than today's. It is, in fact, very unlikely that today's margin between prices and costs will be maintained unless costs can be reduced (although the 1947 Agriculture Act guarantees that fair warning of any downward revision will be given in the annual February Price Reviews). The rest of this article is devoted to a discussion of some of the ways in which a reduction in costs may be achieved.

Lower Fattening Costs There is no doubt that improvements in rationing winter-fed bullocks could often be undertaken. A report[5] published in 1946 by the Midland Agricultural College (as it then was) shows that the amount of protein fed to the cattle costed in that year was almost 17 per cent greater than it need have been. This report suggests, too, that the stock might have been more thrifty if the interest which the modern stockman takes in his work had been up to the standard of a former generation. The difficulties of seeing that the stock are properly bedded down on Sunday and the unwillingness which many men show for weekend work contributed to the poor returns the cattle showed on the food fed to them.

It is less easy to criticize the rations fed in summer, since the only food for many years now has been grass. Yet this itself indicates the importance of grassland management. Farmers do not need to be reminded of the importance of harrowing, ditching, draining, making hedges stock-proof, and I believe it is still the practice on some of the best pastures to collect and spread again the droppings to keep the pastures sweet. In addition, there is the question of manuring and often of ploughing out old pastures and reseeding them. A famous Midland farmer once epitomized the problem of grassland and cattle in this JOURNAL as follows: "Make your pasture and the cattle will get fat on it"[6].

But there is the equally important question of what sort of cattle to rear and fatten, and how to fatten them. Farming systems and practices are always changing. When winter feeding became too expensive the method was changed so that the beasts ran store throughout the winter and were finished on grass. It was possible to do this at a profit even before the rise in prices in August, 1947. The most recent change in the price schedule, with its peak earlier in the season, may, however, encourage farmers to market rather more cattle direct from the yards instead of finishing them on grass.

Another change in methods was brought about by the scarcity and high prices of Irish stores. Of late, many farmers who used to buy big bullocks to feed have preferred to rear their own stores. At present prices most farmers should have no difficulty in rearing their own stores at a profit, but it is doubtful if this could have been said before the effect of the rise in fat cattle prices in 1947 was reflected in the store trade. If costs of beef production are to be reduced, much of the saving must be in cheaper rearing.

Single suckling is a very expensive way of rearing calves if any quantity of hand meat is fed to the cows; the costs of housing them in winter can be justified, if at all, only by its indirect advantages.

If more than one calf is reared the cost of the cow is spread over a greater number of calves, but the amount of labour required in attendance is considerably greater than with single suckling, and it is often difficult to find a supply of calves suitable for rearing. The same is true of pail rearing. It is overcome to some extent by breeding from dual-purpose herds, or by using beef bulls on dairy herds. The second of these alternatives can be applied only to flying herds; it would be fatal on herds rearing their own replacements.

The plane of feeding is the subject of an experiment on the Cambridge University farm, and interim results suggest that success in rearing depends largely on giving the calves a good start.

The well-run dual-purpose herd is a satisfactory way of getting a calf which is well enough bred to turn into beef from a cow which will earn her keep as a milk producer while she carries and later rears the calf. Considerably more skill, however, is needed to maintain a successful dual-purpose herd than a single-purpose herd, either milk or beef. In the U.S.A. and Canada much less crossing between beef and dairy breeds is done than in this country, and little attempt is made there to develop dual-purpose qualities; and it is probably not just coincidence that the average yield of cows in the eastern states of the U.S.A. and the dairying provinces of Canada is some 200 gallons per cow greater than ours. No one can deny that in this country there are some very fine herds of dual-purpose cattle, but taking the country as a whole it is evident that the attempt to achieve dual purpose has too often led to an animal which can only be described as "no purpose".

For many years now the emphasis has been on milk, and there is much to suggest that where the dairy animal and the beef animal compete for land, labour, or stall space, the preference should be given to the dairy animal. Thus the animal nutritionist shows that the dairy cow is a much more economical converter of vegetable matter into human food than the bullock, and the dietician has established that milk has particular virtues for certain classes of the population, which put it in a class by itself. Prices, too, are such that a dairy cow, enjoying an average life of three lactations, will in its life of six years produce per year twice as much gross as could be expected annually of a three-year-old bullock. In fact, the only advantages of the bullock over the dairy cow are its lower labour requirements, its ability to turn coarse food into beef more satisfactorily than the cow can turn it into milk, and its undoubted pre-eminence as a treader of straw into manure.

Unless, therefore, the future leads us into a glut of milk while beef remains relatively scarce, land, labour, and capital are generally likely to be better employed in dairying than in maintaining cows to rear beef cattle. The exceptions are likely to be those farms which are not suitable for dairying and those which can make a satisfactory income without the help of the dairy cow.

But if the supply of home-bred beef is to be maintained, even at its present figure, some steers will have to be reared from dairy cows. The difficulty will be to find stores sufficiently well bred. Some bullock feeders are, however, already buying calves to rear from cows which, although kept for milk production, will yet breed a calf good enough to rear for beef. An interesting account of a Friesian herd that is used for this purpose as well as for milk production appeared in the December, 1947, number of this JOURNAL(7), and several graziers have found steers of the same breed satisfactory. Their advantage lies partly in their size, since they will weigh 14 cwt. or more live weight, while beasts of the same age from other breeds will weigh 11 or 12 cwt. Such rearers will be put on their mettle when the price for beasts of more than 13¾ cwt. live weight will be reduced by 5s. per cwt. next October. If they carry this handicap and still provide as good returns as the lighter weights, they will have gone far towards solving the problem of the most suitable type of beast to rear for post-war conditions.

References

1. THOMAS, W. J. Wartime Fattening of Cattle in Wales. *Agriculture* (1945), **52**, 345.
2. BLACK, D. and OLDERSHAW, A. W. Farmyard Manure I. *Agriculture* (1945), **51**, 487, and MACGREGOR, J. J. *Economic Aspects of Beef Production and Consumption, Harper Adams Agricultural College* (1945), 6.
3. UNIVERSITY OF NOTTINGHAM SCHOOL OF AGRICULTURE. *Grass Feed Cattle Investigation, 1946 and 1947 Results* (March, 1948).
4. BUTLER, J. B. *Costs and Returns for Wintered Cattle in Northumberland*, 1946-47. *Report No. G26.*
5. BOND, W. and MAKINGS, S. M. *The Economics of Yard Cattle Feeding under War Conditions* (Midland Agricultural College, 1946).
6. ASTILL P. F. Fattening Cattle on Pasture. *Agriculture* (1940), **47**, 9.
7. HODDELL, G. P. J. Friesian Bullocks for the Fat Market. *Agriculture* (1947), **54**, 402.

INTENSIVE LEY FARMING FOR MILK

MAITLAND MACKIE, Jnr.
Rothienorman, Aberdeenshire

I HAVE two farms which are run as one unit of 750 acres, with very varying types and depths of soil on it. It rises from 300 to 800 feet above sea level and has a rainfall of roughly 30 inches. It is a dairy farm carrying some 230 Friesian cows and their followers, although at the moment we are carrying only 470 cattle all told. We grow 240 acres of oats and 12 acres of potatoes every year. There are no roots for the cows and, therefore, we are left with about 500 acres of grass which I am hoping will maintain this stocking summer and winter.

For the last two winters I have had to supplement the grass silage with about one ton of wet distillers' grains per milking cow. That leaves room for improvement and an incentive to still better grass. Having decided it was unprofitable to grow roots for winter food, the whole problem became one of using as small an acreage of grass as possible for grazing and conserving what was left as hay and silage.

Three years ago, after many failures with hay, I decided to drop haymaking altogether because I could see that I could always make good silage; that even hay made on tripods and put up very green was never nearly as good as the stuff I cut and, even if it were past the stage for the best silage, I could still make it into silage which would analyse better than hay and there would be no worries about the weather.

Seeding without a Nurse Crop My advice therefore on haymaking is very simple—don't, but if you do, make it on tripods and put it up green. I now lay down roughly 125 acres of grass every year, and all of this has been sown without a nurse crop in the sense of a cash nurse crop. Last year I did sow one bushel of bere along with the seeds to get a quicker bulk of stuff to cut. All kinds of annual weeds come up with the seeds the first time, and the sooner they are cut the better chance the grass gets, and in time I hope we will get rid of these annual weeds. At least they make grand silage along with the growing grasses and are never seen again in that rotation. I have another very important reason for not sowing with a nurse crop: which is, that after the first cut of silage the grasses come up vigorously and are just right for grazing about August 1 when the older grass, no matter how good it looks, is apparently not good enough for milk, as shown by the number of gallons in the cans. The cows then get this second growth to graze, and for the last three years I have been able to stop the usual drop in milk which used to occur at the end of summer and have kept them milking without additional green food up to the end of September, when we start feeding the silage. This, I think, is particularly valuable because in the past one often knew that the cows should be getting some kale, turnips or cabbage to supplement end-of-August and September grass; but because the whole energies of the outside staff were directed to getting on with the harvest I could always invent a very plausible reason for not doing so for another week, then another, and so on till harvest was over and the damage had been done. I have departed from this system this year because I see that enough fertility has been built up in the grass fields to yield three good white crops in succession. This, of course, is a great saving, since I shall have to sow down each year only one-third of the acreage instead of one-half. As I have missed the young, vigorous, resown grasses to which I referred, I have tried manuring heavily with nitrogen some of the older pastures, but although the result looks good, I do not think the milk cans are going to tell such a good story as they do on the new stuff.

I have been using simple mixtures for the last three years, for various reasons. The first reason seems obvious: 13 lb. of a mixture, even with the addition of a little bere or Italian ryegrass, is very much cheaper than the 30 lb. of various grasses and clovers which I used to sow. Second, if various fields are more suited to certain grasses it seemed sensible to sow only that grass and so get as near to a maximum crop as possible. Third, if grazing and management of a mixture of grasses is the complicated difficult business it is said to be, then, in order to retain the original proportion of grasses, the answer was apparently to grow the grasses in that proportion but to sow them in different plots; they would not then suffer from competition and could be cut or grazed at the proper time for each grass and rested at the proper time, which seems just as important. For the last two years, only the Aberystwyth S strains have been used, sowing 10 lb. of either cocksfoot or perennial ryegrass or timothy with the addition of 3 lb. of S.100 white clover. In some of the plots we put down a strip of the much-talked-about

deep-rooting herbs—burnet, chicory, plantain, etc.—but I have no fixed ideas about their value. Two strains of each grass are sown—an early and a late strain ; and this seems a good thing in spreading out the grazing or in keeping back some fields for cutting until the early ones are finished—another good reason for sowing each grass and each strain separately. Restricted rotational grazing is carried on from the time the milking cows go out in April until August, when the second growth from the young grass is ready. Rotational grazing is thenceforward unrestricted, as by that time I can spare more acres and the grass is less rich and no harm is done by the cows taking their fill. Restricted grazing allows me to graze the cows on about ½ acre per cow up to this time, and this releases a lot of grass for silage-making.

Manuring After many trials and troubles my manuring has now settled down to a fairly regular system. In sowing down to grass I merely apply 6 cwt. potato manure and give 3 cwt. nitrogen after the first cut is taken off. At the end of harvest we start putting all the dung on this grass. The earlier I can put on the dung the better I like it. For one thing, as long as a little of the growing season is left, the young grasses seem to respond best to the dung and little will be lost through drainage ; and for another, if the fields are well and truly dunged with about 20 tons to the acre, I am not tempted to let the cattle still left out in October graze them, for the simple reason that they will hardly eat off them—and who could blame the cattle? To the fields that have not got dung in the back-end I try to give 3 cwt. potassic superphosphate. When this was difficult to get, ordinary superphosphate was used. In spring, say March, half the grass acreage will get 5 cwt. of potato manure. Probably all the grass should get this, but with a farmer's natural antipathy to spending money, I persuade myself that in its last year I want to reduce the fertility by manuring heavily with nitrogen and cutting three times for silage, and that in its first year the dung will do instead. The other half of the grass, i.e., roughly second and fourth year grass, will get 2 cwt. nitrogen. Manuring throughout the season depends to some extent on conditions at the time, but roughly I have come to the conclusion that heavy dressings of nitrogen are very profitable after each cut of silage. Last year our best result was from 4 cwt. There seemed little difference between four and five. The rotational plots for the grazing animals are given 2 cwt. of nitrogen only as needed to keep pace with the cows.

The Mechanics of Making Grass Silage One of the bugbears of a root crop for winter feed was the lifting and driving in all winter. Grass silage has certainly simplified this, as I have placed the silage pits for the milking cows right at the cowshed doors. The cattlemen simply take the silage straight from the pit to the cow. As far as the mechanics of making grass silage are concerned, I used to say the best way was to borrow someone else's cutlift, but owners of cutlifts are now becoming very diffident about lending them, so I have one of my own. This machine used to suffer from too much vibration, and for one year we abandoned it in favour of a crop-loader. After some alterations on the farm, however, we have brought it into service again, and for the last two years it has done very good work. When properly adjusted it seems to be still the best I have tried. It cuts cleanly, picks up everything and deals with different stages of grass better than the crop-loaders. We now work two squads during the season, one with the cutlift and one with a mower and loader. The crop-loader is kept as a standby. I have tried to save a

tractor by having the crop-loader coupled to the mower with a special hitch. This works quite well, but in the end I abandoned it because it was most annoying to see the whole business held up because of a broken finger in the mower—a frequent occurrence on our stony ground. I find it better to pay the tractorman to cut ahead of the crop lifter at dinner-time and evenings when a breakdown of the mower will then affect only the one man and one tractor. The same fault, of course, applies to the cutlift, but this is compensated by its clean lifting properties. We have some fields about three-quarters of a mile from the pits, so the number of tractors needed to keep the two units going varies. Close at hand two can do it ; farther off we need three. At the pit, if the tractors driving the grass from the field have time to do it, each tractorman, with the assistance of the man at the pit, forks off his own load. This is rather wasteful of time and labour, but it makes even distribution and tramping possible. If the carting tractors are pushed for time, I have pulled off the load with a double rope previously laid along the bottom of the cart and then over the top of the finished load. This rope can be attached to a fixture at the back of the pit, and the tractor pulls off its own load, but generally wheelslip on the soft grass makes this unsatisfactory, and another tractor, in this case a crawler, is used to pull off the loads and do the subsequent consolidating.

All this looks like a lot of labour and machinery, but several points must be kept in mind. First, silage could be made more economically in the field where the grass is grown, but I find the convenience of having the finished product beside the byre worth the extra trouble and expense. Second, I believe each field is only at the right stage for making good quality silage for such a short time that each cut must be handled speedily. With 200 acres to deal with three times a year, we set 10 acres a day as a minimum to handle. To get this done with the type of equipment available, I have to employ two more or less complete squads and equipments. I think there is a crying need for a machine which will cut, chop and load varying heights and thicknesses of crops at a rate of not less than 10 acres per 8 hours. Last year I tried out an American forage harvester, which promised to do this, but I found it most unsatisfactory, especially in short grass, as the feed into the cutter kept choking. We did manage to reduce the labour by having made special low-loading, high-sided carts which one boy or a man could load, but with a cutter-blower no one should be needed in the cart at all. Also, with loads already chopped, they can be pulled off at the pit and fall automatically into place without much spreading. I think this is a very pressing problem, for, with proper equipment, I am sure the rate of cutting could be maintained with half the labour.

Labour Spread I find that silage-making in summer clashes with the cultivations and work on a root crop. Theoretically, by the time the root crop is sown, the first cut of silage should be ready. Then, by the time the roots are ready for singling, the first cut should be finished, and when singling is over more silage can be made ; after that, land cleaning of the root crop can go on until a further cut or hay comes on. In practice, the two often coincided and neither root singling nor silage-making is an operation that can wait. The result was either the spoiling of one crop or employing a lot of casual labour. In most districts casual labour is difficult to get, expensive to employ and, in any case, a bad thing for the country. We should try to base our production and work for the year on a regular staff, and ensilage or grass drying without roots for stock-feeding seems to make this generally possible. Although I have not yet got the silage-making sufficiently mechanized, I can see it coming, and it does leave

the staff free for much longer periods than in the days of the root crop for the hundred and one other jobs which have to be done. The work spreads itself well throughout the year. With grass as the basis of the summer work, by sowing single grass mixtures with different periods of growth, and by the planned application of manures, we can spread out the handling of the crop so that all is eaten or conserved as nearly as possible at the right times. Taking the eight months of the year from March 1 to the end of October, there are about 189 full working days, and if we take the major operations which employ the whole staff for that time, I think we ought to be able to do them in 145 days, spread out roughly as follows:

Putting in crop and laying down grass seeds from March 1 to April 10, say 21 days out of 32 available.

Driving out muck from sheds before May 1: 14 days. (17 days available).

Silage-making or grass drying first; second and half third cuts before August 1: 50 days. (67 days available).

Harvest, potatoes and half third cut before October 8: 46 days. (55 days available).

Drive out muck from sheds before October 31: 14 days. (18 days available).

These figures correspond roughly to my timetable last year. They would, of course, be different for other districts, and many farms would have other major operations to fit into the schedule. I put them forward only as an indication of the fairly even spread of days throughout the whole season left to do the many other jobs on the farm which do not call for the whole outside staff. These days make possible the extra manuring and extra fencing needed to ensure maximum production and maximum use of our grass. The result of our summer's work in having already got our stock feed ready for consumption beside the animal is that the winter's work is simplified considerably. Liming, threshing, potato dressing, dunging the grass and, of course, ploughing, occupy the staff fairly regularly, but the time formerly spent on carting roots can now be spent on all the extras we have intended doing but never seemed to get round to. Last back-end, which was particularly fine, I was able to build two fairly big sheds, mostly with my own labour, in addition to a lot of odd jobs that had been badly neglected.

One Acre, One Cow, One Year That, then, is roughly what I have been trying to do with my grass. I would now just like to run over what I think should and could be done with this crop. First, I think we should aim at making one acre of grass keep one adult animal for a whole year. This may appear ambitious, but I am sure it can be done. I think we could summer the animal on half an acre and conserve the other half, either as silage or dried grass for winter keep. This cannot be done without fairly heavy dressings of fertilizers. The grass must also get the dung in its first year and preferably be put on early in the end of the year. All grass that doesn't get dung should get some potash and phosphate in the end of the season to stock up the root system so that growth will start with the first breath of spring. The soil should, of course, be tested and the liming and manuring adjusted accordingly.

In the main I think it is profitable to sow the grass seeds without a nurse crop, although there is a loss of some six to eight weeks at the beginning of the season. This loss, I think, is easily compensated by the value of the late growth of reseeded pasture and by the fact that one can grow a full crop of grain in the previous year without fear of spoiling the grass seeds, either by shading or lodging of the crop. Two methods can be employed to lengthen the grazing season at both ends and to spread out the work of conserving the grass for winter. First, sowing single grass mixtures which will come at different times. Each plot of different strains to be grazed should be fenced separately and eaten on a rotational system and rested at the appropriate

time to suit its next season's growth. The fields set aside for cutting (also sown with different strains) will come to the optimum stage for conserving at different times with all the plants in the field at the same stage whereas, in a comprehensive mixture of grass, some are bound to be too mature and some not mature when cut, so lowering the value of the product and incidentally altering the proportions of the grasses for the next cut.

In laying down these simple mixtures at a low seed rate, I find the most important thing is to have all the work in making and manuring the land finished, then roll once or twice with a Cambridge roller, broadcast the seeds in the ridges, cover with a light chain harrow pulled along with the broadcast sower, and roll again twice. I have tried drilling the seeds without much success, probably because I put the drills too far in.

At the expense of a little more work I like to make the finished product where it is going to be used. I cannot see any place for haymaking because, although it is easy to mechanize, the finished product is rarely as good as it should be and never as good as silage or dried grass. A better forage harvester is needed, but in the meantime a cutlift or green crop-loader with special carts makes quite a good job. Where possible, the pits for silage should have cement sides and hold at least 6 feet of settled silage, because the top is always more difficult to consolidate and the less there is of it the better. Sisal paper and cement slabs make a good covering. The slabs are expensive but very convenient to put on and take off; it is easy to remove them after a first cut has been put in and settled and another cut made on top of the first. If soil is used, a tractor scoop will save most of the hand labour. I do not think silage-making fits in well with growing roots, and I would cut out the winter root crop altogether, which then simplifies both summer and winter work. I believe that if the goal of one beast per acre were achieved the amount of dung which would be made would eventually reduce the amount of artificial manures which needs at present to be applied. In an attempt to reduce the fertilizer bill I had the idea of folding hens over the grass once in the rotation, but so far I have only 1,000 hens in folds. These birds will cover only about 30 acres in a year, but already in a field I imagined was in good heart and had good grass you can see the difference the humble hen has made. Incidentally, they did not reduce the amount of available grazing at all.

AGRICULTURAL INDEX NUMBER

MONTHLY INDEX NUMBERS OF PRICES OF AGRICULTURAL PRODUCTS INCLUDING GOVERNMENT GRANTS. (BASE 1927–29 = 100)

Month	Uncorrected for Seasonal Variation					*Corrected for Seasonal Variation*				
	1939	1946	1947	1948	1949	*1939*	*1946*	*1947*	*1948*	*1949*
January ..	96	199	217	241†	245†	*89*	*179*	*193*	*215*†	*218*†
February	94	201	211	240†	243†	*88*	*182*	*190*	*217*†	*220*†
March ..	90	192	201	232†	238†	*91*	*183*	*191*	*220*†	*225*†
April ..	90	176	186	214†	228†	*95*	*182*	*192*	*222*†	*237*†
May ..	82	162	171	198†	208†	*91*	*181*	*192*	*222*†	*236*†
June ..	80	161	170	197†	207†	*89*	*181*	*193*	*225*†	*237*†
July ..	85	168	181†	198†		*93*	*182*	*197*†	*216*†	
August ..	87	176	192†	211†		*91*	*191*	*208*†	*228*†	
September	93	177	206†	210†		*93*	*188*	*222*†	*227*†	
October ..	97	192	221†	226†		*92*	*187*	*215*†	*220*†	
November	107	209	235†	239†		*98*	*192*	*217*†	*221*†	
December	114	214	241†	245†		*104*	*192*	*216*†	*221*†	

† Provisional.

THE USE OF RECORDS IN BREEDING DAIRY CATTLE IN DENMARK AND THE NETHERLANDS

E. D. Ashton

Bureau of Records, Milk Marketing Board

At no time have the problems of the British breeder of dairy cattle been so fully realized as they are today, and at no time has there been such unanimity about the broad lines along which they should be tackled. Future progress depends on co-operation between all the groups interested—the professional breeder, the commercial producer and the scientist—and recent events have shown that we may expect the co-operation to be close and fruitful. The instruments of progress lie in study and selection based on detailed factual evidence, and the aim is to build strains of superior breeding stock as a foundation of our national herd.

Both our neighbours, Denmark and the Netherlands, have had long experience of this kind of policy—the application of breeding data on a national scale to livestock problems. It is interesting to see the progress they have made and how this has been achieved. The farming pattern in both countries is one of heavily stocked smallholdings devoted to intensive and specialized dairying. The dairy breeds are few and cross-breeding scarcely exists.

The location of each breed is concentrated rather than scattered. In the two main Danish islands of Zealand and Fyn, for instance, of 550,000 cows, 530,000 are of Red Danish breed. In the Netherlands whole provinces are populated entirely by the Black and White Holland breed; the Red and White breed is concentrated in the south-eastern corner of the country, north of the great rivers along the German frontier; Gronigen cattle are found in the province of that name, with a small enclave in the province of South Holland. Boundaries between the breeds are clear, and only very small areas are populated by more than one breed. No doubt such a concentration is the result of slow development over many years and has been influenced largely by uniformity of soil types. The Black and White Holland breed, for example, is found on the better land which has in recent centuries been reclaimed; the Red and White (M.R.Y.), with a less developed milking capacity, is adapted more to the lighter soils of the South and East.

The methodical keeping of ancestry records and their publication has been going on in both countries since the end of the last century. In both, the milk recording service has been harnessed to breeding on a national scale since before the first world war, with the result that strains of breeding stock have been developed with yields of 200-400 gallons above the national average.

Denmark There is little doubt that the Danish system is administratively the simplest arrangement for using records *en masse* in breeding work. Here the responsibility for the production of Herd Books and for the milk recording service lies in two branches of the same organization—the Danish Association of Agricultural Societies. The provincial offices of the two branches are usually in the same town, and in one case are under the same roof and under the supervision of the same official. At field level the relationship continues to be very close, frequently involving the same member of the staff in duties covering milk recording and breeding advisory work.

This traditional alliance between milk recording and breeding is at the foundation of Herd Book work. The Family Herd Book, for instance, is compiled when a herd has been recorded for three generations and the type

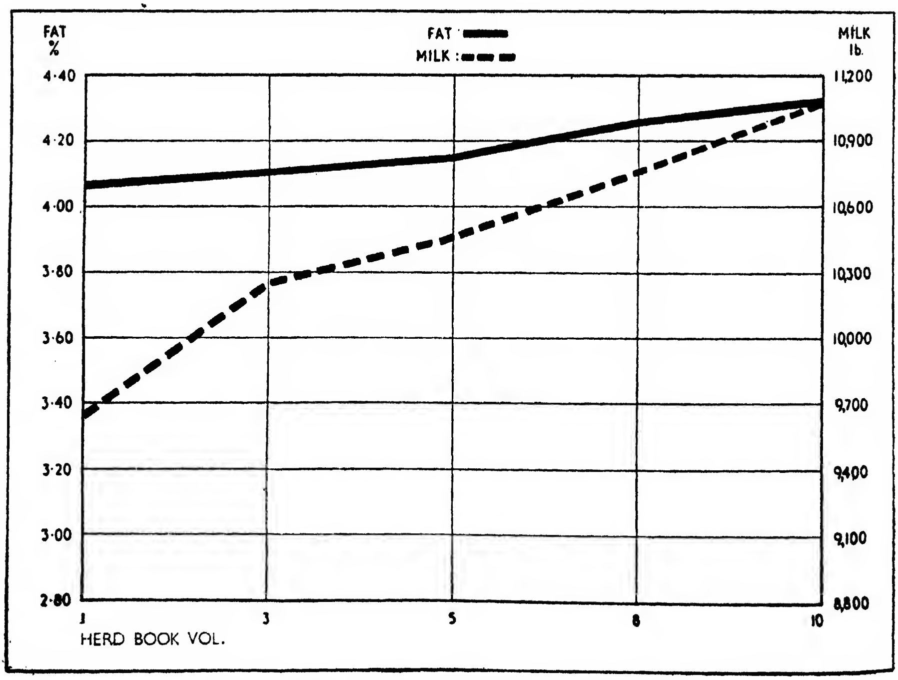
of animal is considered satisfactory. This book is kept up to date each year by officials of the Danish Agricultural Societies, and it forms the basis of the published Herd Books for Young Animals, for Cows and for Bulls. Registered cows and bulls must conform to standards of performance and type prescribed by the D.A.A.S. Cows must have produced at least 880 lb. of fat in two successive years. With bulls, the yield of fat of the daughters must show an increase on their dams or be at least 350 lb. of fat for the average of first and second records, or 396 lb. of fat for mature records. Conformation standards are in terms of measurements—height, depth of chest, length of body, and so on.

Herd Book standards are not static but are reviewed each year to preserve the elite character of the Herd Book. The degree of selection is great: annual entries in the Cow Herd Book of the Red Danish breed can be counted in hundreds, although there are some half a million cows of this breed which have been recorded for a number of generations.

The effect of such a rigid process of selection is illustrated by the graph below—a steadily rising trend for both milk and butterfat content has been maintained.

The Red Danish Bull Herd Book is a typical example. The 1942 edition, for example, is a well-produced book of 190 pages containing information on the 96 bulls registered for that year. Some of the facts disclosed are worth reproducing :

1. 52 of the bulls are in direct male line to one bull, and the other 44 are descendants of another bull. Both bulls are well known all over Denmark.
2. On average the 96 dams milked for between six and seven lactations.
3. The most frequent calving at which the bulls were born was the second.



Source—Red Danish Cattle Herd Book, Vol. 10, 1930.

The outstanding feature of this Herd Book is the wealth of information, both on the ancestry side, denoting emphasis on longevity and records, and also on the progeny side, in conformity with the prescribed standards. It is this wealth of information which accounts for the advanced stage reached in establishing strains of breeding stock.

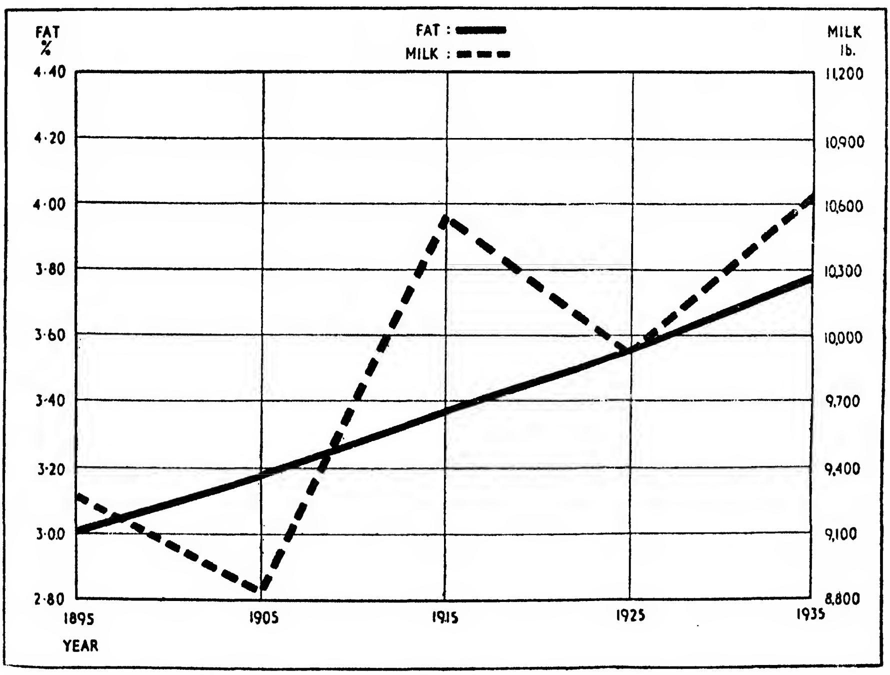
While Herd Books are restricted to well-ordered details of a very few elite animals, the published reports of the Milk Recording Associations give full publicity to the performance of recorded herds and of males and females in those herds. As milk recording covers 50 per cent of the cattle in the country, detailed information on performance of the more important half of the national herd is available each year.

Government action has been restricted to giving financial assistance from time to time (and until the recent war on a very limited scale) to local Recording and Cattle Breeding (i.e., bull clubs) Societies. The activities of Breed Societies do not usually extend beyond breed publicity: the term pedigree, as it is used in this country, is unknown.

The Netherlands Here a rather more complicated administrative structure has prevailed, because two separate organizations have existed for the production of Herd Books and for Milk Recording. In addition, the State has taken an increasing interest, particularly in recent years, in breeding and recording.

Breed Societies, as such, have always had a very important influence on cattle breeding, and their membership, which has advanced rapidly in recent years, now exceeds 30,000 for the three breeds. They are responsible for Herd Books.

The Netherlands Cattle Herd Book Society (N.R.S.), operating from its office at The Hague, is responsible for Herd Books for all three breeds and covers



Source—*The Black and White Friesian Cattle*, a pamphlet published by Leeuwarden Herd Book Office.

the entire country, except the province of Friesland which, in its own office at Leeuwarden, produces a separate Herd Book for the Black and White Holland breed in that province. At these two offices, registers of young cattle and of cows without full pedigree are kept. Herd Books are published for pedigree cows and bulls.

Calves entered in the register of Young Cattle must have registered parents and bull calves, and must be from ancestry with yield qualifications. The register of cows without full pedigree is much the same as a Grading Register in this country, except that the standards are based on conformation only. Entries in the Herd Book proper must have appeared previously in the register of Young Cattle and must comply with detailed standards of conformation, which include a consideration of head, legs, milk indicators, and general appearance. These standards have had the effect of restricting the number of entries and of raising the general quality level.

In addition to Herd Book entries, a special merit list is published. This includes cows reaching certain standards of yield as well as of conformation, and bulls proved for both.

In recent years the State has taken considerable interest in cattle breeding. By the operation of a Premium Bull Scheme since 1943 (when 136 bulls were awarded a premium) and by the establishment of State-sponsored "Commissioners for Stockbreeding" for the study of old bulls, it has made known and extended the influence of the best bulls in the country. This work is carried out in close co-operation with the Herd Book authorities, and the detailed information in these Commissioners' reports on good bulls is an important feature of the Dutch livestock industry. Dutch authorities were able to point to two outstanding sires of the Black and White Holland breed, one in the Netherlands Herd Book and the other in the Friesland Herd Book, which have had the most beneficial effect on the breed. These animals would not have been given the prominence they deserved if the full arrangements for studying bulls had not been operating.

The Milk Recording service is carried out independently of Herd Book Societies through the Association of Dairy Factories under a State inspectorate and with State financial backing. The operational unit, as in Denmark, is the local milk recording society (a recorder's circuit) and local societies are grouped together into eleven Provincial Associations which have, since 1943, been brought together under a central office at Arnhem, covering all provinces except Friesland. The service, which now covers 36 per cent of the cows in the country, has always been influenced by the Herd Book Societies, and the administrative arrangements are fashioned to facilitate Herd Book work. Further developments in dissemination of information have been planned by the central office.

Achievements These two countries occupy a leading place in the breeding of dairy cattle. In both, breeding plans have been developed ever since the establishment of Herd Books and the formulation of a standard technique for milk recording and butterfat testing in the late nineteenth century. There is an apparent difference in emphasis on conformation and yield in the two countries ; the Netherlands appears to stress the former, and Denmark the latter. The extent of this difference, however, is very difficult to assess. In the Netherlands, for instance, all young bulls must be out of dams and grand-dams with good production records ; hence every breeder interested in breeding bulls automatically sees to the yields of his females. Moreover, all elite cows and bulls must qualify on production as well as on conformation. In Denmark, on the other hand, in spite of the apparent attachment to yield, the basis of all breeding work is the Family

Herd Book, use of which is restricted to herds approved on the basis of conformation. The difference, therefore, seems to be more apparent than real.

There can, however, be no mistake about the common purpose of these two countries. Both have tried to breed an economical producer of butter fat, and the broad lines of policy have been identical—the assembly of a multitude of facts on ancestry and progeny and the creation of a carefully selected elite breeding stock. The administrative details have been divergent, but now, after fifty years' work, they have both reached practically the same stage of development. The explanation of such an achievement lies in the use of the two instruments, study and selection.

THE GRASSLANDS OF DENMARK

Dudley E. Eyles, B.Sc. and T. A. Evans, B.Sc.
Grassland Research Station, Stratford-on-Avon

DENMARK is a small country, about twice the size of Wales. Of this, Jutland represents two-thirds of the total area, and the remaining third consists of islands, the two largest being Funen and Zealand. The climate is similar to that of the eastern counties of England, except that the winters are more severe. The country is very flat and windswept, the highest hills not exceeding 500 feet above sea level. In general, the soils of north and west Jutland are represented by light loams, while the soils of the islands and the rest of Jutland are heavier. These soils are easily worked but are not inherently fertile.

General Farming Denmark has no mineral or coal deposits, so that the Danes have been forced to make the best use of their chief raw material—the soil. A quarter of her population of four millions is engaged in agriculture, the agricultural area occupying three-quarters of the country. Agriculture has displaced the forests and heaths to such an extent that only 6.9 per cent of the land surface is not usefully employed. Farming is intensive. The average size of a farm is 43 acres ; half the farms are under 25 acres and only one per cent are over 250 acres.

The mainstay of the agricultural industry is the dairy cow, with pigs and poultry forming subsidiary enterprises. Most of the milk produced is made into butter and cheese at co-operative factories, and the skimmed milk and whey are fed to pigs. During the war, the number of dairy stock was maintained at pre-war levels but, as feedingstuffs could not be imported, the pig and poultry populations were severely depleted.

Allocation of the Agricultural Area For comparative purposes the percentages of agricultural area occupied in 1945 by arable land and by grassland in Denmark and in England and Wales respectively are given below :

	Denmark	England and Wales
Permanent pasture (including rough grazings)	15	51.4
Arable	62	37.0
Ley	23	11.6

Arable and ley are obviously most important in the Danish farming system. Compared with England and Wales, the percentage of permanent grass is very low. The reason for this is the low yield per acre from permanent pasture. Permanent grass is mainly situated on land which is difficult to cultivate, such as the marshes and moorland peats. In West Jutland, which has a higher rainfall and several areas unsuitable for arable cultivation, permanent pasture occupies a larger percentage of the total area. A farm may have one permanent grass field near the buildings. The permanent pastures are usually of poor quality, being dominated by bent (*Agrostis* sp.) and meadow grasses (*Poa* sp.), and associated with *Festuca rubra* on the drier soils and *Deschampsia caespitosa* on the wetter soils.

Most of the crops are grown for livestock consumption. The rotations are generally seven or eight course, e.g., oats-wheat-roots-barley-sugar beet-barley-ley-ley. A long rotation is desired, since *Sclerotinia* (clover rot) and eelworm infestation of clover are widespread. The ley occupies two years and is essentially a hay ley.

This is a typical mixture used for a two-year hay ley:

	lb. per acre
Perennial ryegrass	4
Timothy	4
Meadow fescue	2
Red clover	9
White clover (Morsø)	2
TOTAL	**21**

The high seeding of red clover ensures a hay crop containing a high percentage of clover in spite of winter killing, clover stem rot and eelworm attack. Early and medium-late strains of red clover are used. In a severe winter the early strains are killed. "Morsø," a Danish type of white clover, is more productive than English wild white, but persists for only three or four years. The grasses have been bred for high yield of dry matter and are of a stemmy hay type. Italian ryegrass is not sufficiently winter hardy and is not therefore included in the mixture; even perennial ryegrass is killed during severe winters. The total rate of seeding is similar to that commonly used in Britain, the main difference being in the high proportion of legume to grass.

The hay ley is everywhere broadcast under a cereal—usually barley. The young seeds are not grazed either in the autumn or in the spring, and an early hay cut is taken. The hay is cured on tripods in order to preserve the leaf. Every cowshed has its loft in which the hay is stored; a hayrick is a rare sight. The aftermath is grazed by dairy cows, the traditional practice being to tether the animals in line across the field. On the larger farms some use is made of electric fencing.

Lucerne The acreage of lucerne grown in Denmark in 1945 was 64,467. The main varieties used are Canadian Grimm and improved Danish strains derived from crossing the former with *Medicago falcata*. Recent experiments indicate that Dupuits, a French strain, is likely to give a higher yield of dry matter and to be a better producer of seed than varieties previously in use.

Lucerne is usually sown in narrow drills under barley at a rate of 22 lb. per acre. Sometimes 1 lb. per acre of timothy is added in order to fill the bare ground which would otherwise be colonized by weeds. Lucerne seed is always inoculated with the appropriate strain of bacteria. This helps to ensure good establishment, which might otherwise be poor owing to severe

winters and *Verticillium* wilt. The latter was first recorded in 1941 and is now of more frequent occurrence. To ensure some hay if the lucerne fails, 2 lb. per acre of red clover is often added to the seeds mixture. Three hay cuts per year are taken and the ley is rarely grazed. Four cwt. per acre of potash salts and 3 cwt. per acre of superphosphate are applied after the last cut of the season. The duration of the lucerne ley is three or four years.

Pasture Leys At present the Danes do not employ grazing leys to any material extent. The following is a typical mixture designed for a long-duration grazing ley :

	lb. per acre
Perennial ryegrass	5
Meadow fescue	9
Smooth-stalked meadow grass	7
Timothy	4
White clover (Morsø)	3
English wild white clover	3
TOTAL	**31**

The seeds mixtures used are similar to the "Cockle Park" type of mixture and suffer from the same drawback of low production during the summer drought. The high value placed on smooth-stalked meadow grass (*Poa pratensis*) is due to its ability to withstand drought. Perennial ryegrass, which is sown widely in Denmark, is unproductive during this period. Meadow fescue is much more resistant to dry weather and, although it has the added advantage of being decidedly more winter hardy than perennial ryegrass, it is less frequently sown. It is doubtful if the Danes are making enough use of meadow fescue. English wild white clover is included in the long leys, as Morsø is short-lived. Many of the species sown in the "complex" seeds mixture never contribute to the sward at all, either because they are not suited to the environment or because the management of the ley tends to suppress them. No attempt is being made to use special mixtures for particular soils and climatic conditions.

All the species are bred at private breeding stations for high dry matter and high seed yields. The State trials, which compare all the new strains, also take careful note of these qualities. Emphasis is placed on them because the Danish farmer has been interested in leys primarily for hay and for seed production—an important export industry. The Danes have no commercial stocks of the pasture strains of grasses.

Grazing begins in May and ends in late September when all the cattle are brought inside for the winter. Drought during the early summer seriously curtails pasture growth. During the exceptionally dry spring and summer of 1947, for example, the pastures produced very little keep. A few farmers had mustard, lucerne, lupins, fodder beet and silage for their stock, but the majority had no provision for the "summer gap" in pasture production. Consequently many cattle were slaughtered.

Reclamation Denmark has to import all her coal, so that peat is used extensively as fuel. It is cut from an area in Zealand where the vegetation is dominated by silver birch and scrub. Peat is also obtained in large quantities from the moors of Northern Jutland. The dominant species on these moors are heather (*Calluna vulgaris* and *Erica tetralix*), and bogmoss (*Sphagnum cymbifolium*). The peat is removed from the surface to a depth of two feet and is then stacked to dry. After sieving it is transported to a factory, where it is compressed into small blocks.

In Zealand the area is regrassed after the removal of the peat. Lime, superphosphate and potash are applied, and a grazing mixture similar to that already quoted is sown. The problem of reclamation on the moors is different, since the land has to be drained and the heather burnt before cultivation. Two years later the soil is cultivated with rototiller, heavy discs and rollers. The plough is not used because the peat is too soft and spongy. The tractors and implements have special wide wheels so that they do not easily sink into the soil. The grazing mixture is in this case usually sown in May *without* a cover crop. A light hay crop is taken in the seeding year. After grazing for eight years the ley is ploughed and two successive potato crops are grown. It is then regrassed as before. The dominant species in the pasture are smooth-stalked meadow grass (*Poa pratensis*), bent (*Agrostis* sp.), and white clover.

Marshes along the west coast of Jutland and the shallow fjords of Zealand have also been reclaimed. Here open ditches drain into main outlets in the dyke wall, where there are either sluice gates or pumping stations. The *p*H of the soil is low. Heavy dressings of marl, together with phosphate and potash, are given before cropping. A rotation of the type corn-roots-corn-long ley is employed. The sown pastures tend to deteriorate, with tussock grass (*Deschampsia caespitosa*), meadow foxtail (*Alopecurus geniculatus*), and dogstail (*Cynosurus cristatus*) becoming dominant.

In all this reclamation work little investigation has been carried out to find the most suitable types of grasses and clovers. Trials laid down at the reclamation centres comparing grasses are cut three or four times a year. The strain with the highest total yield of dry matter is considered the best, irrespective of its leafiness, growth curve or nutritive value.

HIGH QUALITY KALE SILAGE-MAKING

P. G. Swann, N.D.A.

National Agricultural Advisory Service, South-West Province

On a hill farm, known as Eastern Farm, Bishops Cannings, the property of Messrs. J. Horton and Sons and managed by Mr. Alan Smith, the problems of cheap kale silage production have largely been overcome after experience gained last year in the growing, cutting, and ensiling of 7 acres of kale.

The marrowstem kale grown in this instance was drilled as a first crop from an old, worn-out, permanent pasture field. The only cultivations carried out before drilling were three disc harrowings and a heavy rolling, and the kale was drilled at the rate of 8-9 lb. per acre, in rows spaced 21 inches apart.

Earlier, this particular field was found on analysis to be deficient in potash, and, prior to drilling, 1 cwt. muriate of potash and 1½ cwt. nitrogen per acre were broadcast on the kale seedbed. The actual sowing took place in the third week in April and the kale, germinating quickly, was not thinned out ; the only cultivation after drilling was one inter-row scuffling.

The crop was not originally intended for silage, but its lush growth during the second week in October presented a problem as to the best way of conserving it for winter keep. The following procedure was adopted

for cutting, carting, chopping, and ensiling. The initial cutting out of the headland in the field was made with a mower, and the difficulty experienced in picking up the crop from the two or three swaths cut amply illustrated the need for a more efficient method of cutting and picking up. After the crop from the three full swaths had been cleared, a standard trailer-type 7-ft. cut binder was used behind a tractor on spade lugs. The binder cut and tied only one row of kale at a time. The cutting of two or more rows was tried, but was found not to be so efficient a time-saver as was expected.

The kale, cut and tied into sheaves, was then picked up and loaded on to low-loading trailers and carried straight to a high-capacity cutter-blower. The cutter-blower mechanism only of an American-type forage harvester, powered through the p.t.o. of a medium horse-powered crawler tractor, was used and found to be very effective. The average capacity of this cutter-blower, without working to straining point, was approximately one ton of kale in sheaf every six or seven minutes.

The chopped material was made into a clamp roughly 20 yards long by 6 yards wide, and the cutter-blower behind the crawler tractor was easily manœuvrable up and down the length of the clamp, thus ensuring an even spread of chopped material. This spreading of the kale in layers along the clamp facilitated the warming-up of the mass.

The kale crop, from various weighing experiments in sheaf, was estimated as giving a yield of 30-35 tons of green material per acre.

The working unit was made up of three trailers and two tractors in addition to the cutter-blower and crawler tractor and, with a total labour force of three men and one boy, ensiled daily 45-50 tons of kale.

The following points of maintenance on the binder are worthy of note :

(1) that the knife had to be lubricated fairly frequently ;

(2) that the bottom and elevator canvasses required attention at regular periods, i.e., tightening up or otherwise, depending upon the weather and moisture on the crop at the time of cutting. The cutter-blower mechanism also required regular and constant grease and oil maintenance, as the wet kale, working at high pressure, was apt to force grease from the bearings.

In the first instance the chopped material, when spread to a depth of 18 inches over the clamp site, was allowed two days to heat, and the next layers applied were found also in time to warm up as desired.

Analysis of the material in the clamp showed a crude protein content of 20.8 and a starch equivalent of 55 in the dry matter. The moisture percentage was 87, and the fermentation was typical of well-made silage with a remarkably high protein content. This material was fed at the rate of 50 lb. per day to each milking cow, in addition to a maintenance ration of 14 lb. of hay, this being suitable for maintenance and production of 1½ gallons. For cows yielding over 1½ gallons, the balance was made up with a mixture of crushed oats and dairy nuts.

No difficulties were experienced in feeding this material when the cows were first turned on to it, and an increase in yield and betterment in the quality of milk were noted and persisted.

MAN, POTATOES, AND THE DEVIL

E. C. LARGE

National Agricultural Advisory Service, Eastern Province

FOR at least a thousand years before the discovery of the New World the Indians of South America were very familiar with potatoes. They found a number of species growing wild in the uplands of the Andes, at 8,000 to 10,000 feet above the level of the Pacific Ocean. As time went on they selected and cultivated the kinds which they found best for food, and by exposing tubers to frost, treading the soft mush, and leaving it in the wind to dry, they also made the first dehydrated potato product, which now and for many centuries past has been known as *chuño*. They carried this food with them for sustenance on their wanderings, and in their art and imagination the very shapes of potato tubers became symbolic of human life. Their potato pottery of the Proto-Chimu period in Peru, perhaps about 1000 A.D., signified not only human food and human fecundity, but cruelty, nameless terrors of the forests, and "man's inhumanity to man". With the rise of the Inca civilization, the strange powers for good and evil which the Indians saw in potato tubers were beneficial to the tribesfolk. They made great and good use of potatoes. They brought them down from the mountains by llama transport to trade with the tribes of the coastal plains for maize, fruit and beautifully woven cloths. They built huge potato stores, to absorb gluts in the form of the dry *chvño*, and to supply the needs, in times of scarcity, of every man, woman and child in the vast Inca state. They enjoyed a mixed dietary of potatoes, llama and guinea-pig meat, fruit and maize; and while this mixed dietary persisted all was well. Then came the Spaniards. The high social organization of the Incas was overthrown almost overnight, and those Indians who were enslaved and set to work in the mines suffered the potato evil. The Spaniards discovered that potatoes alone were just sufficient to keep slaves alive . . .

That is a little of the story that Dr. Salaman has to tell in the opening chapters of his momentous book.* With a great wealth of documentation and close historical research, he traces the history of the potato from antiquity in South America to its comparatively recent introduction into Europe, and thence through its period of trial and adoption, up to the present time, in each of the four quarters of the British Isles: England, Ireland, Scotland, and Wales. He also records the history of the potato in St. Helena, Jersey, and Tristan da Cunha. The book runs to nearly a third of a million words. There are over a hundred fine illustrations, as well as maps, appendices, statistical tables, and a most interesting additional chapter by W. G. Burton on modern industrial uses of the potato—none of them more ingenious than the old Indian *chuño*. The book is long and at times almost as digressive as history itself; it is a source-book of information for students and statesmen; it contains new material for many a good school lesson in vital history and geography; throughout its pages there is much of practical interest to farmers, especially on methods of cultivation, old and new; but above all the book makes good reading. It is written by one of the world's leading scientific workers on the potato, who began life as a doctor of medicine and has never lost the doctor's realistic view of humanity. There is also something of Faust about it all. Underlying the whole writing of the book, and giving life to it, is a deep concern with eternal problems of good and evil. It is a doctor's vision of Man, Potatoes and the Devil.

---

* REDCLIFFE N. SALAMAN. *The History and Social Influence of the Potato.* Cambridge University Press (1949). 50s.

The story goes on. At some time in the latter half of the sixteenth century—before 1570, on evidence that Dr. Salaman has himself unearthed—potato tubers, with all their supposed latent powers for good and for evil, were brought to Europe by the Spaniards. It was a fateful event, and Dr. Salaman devotes the whole space of many a lesser book to brushing aside the shrouds of legend and error in which the whole matter has so long been wrapped, and exposing the true links between potato cultivation in the Old World and the New. We find here the earliest descriptions and drawings of the potato in European Herbals—with much about the character and veracity of herbalists. We find critical examinations of the old records in the light of recent explorations in South America, in attempts to determine which of the many South American species were in fact the parents of the potato with which we are familiar, and from what part of the Andes they must have come. We lose all faith in the old school-book story that Sir Walter Raleigh brought our potatoes from Virginia, for in truth he never went to Virginia, and would not have found any potatoes there if he had done so ; but we gain an entirely new and true conception of the wealth of potato species and varieties growing in the Andes, many of them still awaiting adaptation to our western needs ; and we find ourselves linked through the potato in a new and surprising kinship with the original peoples of South America. We also learn, again to our surprise perhaps, that the first real use made of the potato by western man was for ships' stores, and that chiefly as a cure for scurvy, for which purpose it was remarkably effective, owing, as we should say nowadays, to its content of vitamin C.

About the time of the Spanish Armada, and as likely as not by one of the Spanish ships dispersed by the storm and wrecked on the Irish coast, the potato reached Ireland. There on the rich bog lands, favoured by a moist and temperate climate, spared the worst ravages of virus disease by the paucity of greenflies, the potato found a new home. It came to a people whose tribal chieftains had been expropriated, and whose social system had broken down under the influence of Tudor feudalism, even as the Inca civilization had fallen at the hands of Spain. To these people the Devil proffered his gift of a new and prolific food plant, easy to grow on the smallest plot of land, demanding no co-operative effort and no real art of agriculture for its utilization, easy to cook, and containing just enough of minerals and protein, as well as of carbohydrates, to be almost a complete food when eaten in sufficient quantity. The gift was all too readily accepted. Chapter by chapter, through the seventeenth, eighteenth and nineteenth centuries, Dr. Salaman traces the result. The Irish multiplied but lived in hovels with their pigs. Becoming utterly dependent upon their potato plots, they were exploited for rent by alien landlords, levied for tithes by the church, pillaged and overrun by a hungry soldiery, and left without will or power to manage their own affairs. Then, in 1845, the Devil laughed. His gift rotted in the hands of its recipients. Blight, *Phytophthora infestans*, call it what you will, laid waste the potato crops. Gaunt and pestilential famine decimated the Irish people and left rents in the fabric of society that have not closed to this day.

In England the adoption of the potato was slower ; it has never become more than an important *part* of a mixed dietary, and a certain stubborn refusal by the English working class to accept admixture of potato in their staple wheaten bread appears to have done more than anything else to save England from any really catastrophic potato disaster. But in the Highlands of Scotland there was tragedy again. After Culloden, in 1746, the Highland chieftains and landowners, divested of their former judicial powers, turned to sheep-ranging on a vast scale, and drove out the clansmen from their holdings

in the glens, to live as crofters and cottars on small plots of boulder-strewn land by the sea ; there to accept the gift of the potato, with a little fish, for the bare maintenance of life, and to be exploited and wrung dry for rent of once valueless land, where a more noble demand, for fair shares of meat and of grain, would have enforced a better deal and saved the Highlands themselves, which were soon to sink into mere hunting and fishing preserves.

"Who sups with the Devil needs a long spoon." That is the moral of Dr. Salaman's book. Potatoes, as part of a mixed dietary, are excellent fare. We could eat more of them than we do in England today, with advantage alike to our national stamina, our agriculture, and our dollar reserves. But whenever too much reliance is put on potatoes alone, either on the farm, or as food for a people, the result is a cumulative lowering of the standard of living and of agricultural practice, often ending in disaster. Potatoes are no longer too easily grown. We stand in no danger of demoralization on that score. The modern mass production of potatoes is about the most laborious of all work on the farm. The modern devil of potatoes is that they come of a vulnerable plant, and we cannot rely on their giving a yield high enough even to cover their bare cost of production unless we treat their cultivation with the utmost watchfulness and care.

Sense and Science are the long spoons we need before we dare trust to potatoes for supper ; sense in such matters as not taking potatoes too often on good potato land, lest we spoil it with eelworm ; in keeping out the Colorado beetle from across the Channel ; and in planting good certified seed, and not stuff that is a little cheaper but may be full of virus disease. Science we need in the form of long-term, sustained and adequate investigation, to improve our potato varieties, to put to use all the newly discovered solanaceous treasure of South America, to rid our seed still further of virus diseases, to find means of combating eelworm, to reduce storage waste, and perhaps at long last to fulfil the oft-repeated promise of Blight-resistant varieties.

APPLE-PACKING

F. C. Penney

Manager, Kirdford Growers, Ltd.

ON a visit to America last autumn I was able to visit a large number of packing houses in California, Oregon, Washington and British Columbia and discuss common problems with growers. Apple-packing in the Pacific North-West is still carried on in the conventional manner in standard, non-returnable, diagonally-packed, wooden apple boxes. There are signs, however, that America is entering a complete self-service era in the retail trade as far as foodstuffs are concerned. This may very well mean that the bulk package will soon be out of date and replaced by a consumer package of from 3 to 10 lb. Experiments have been carried out with all kinds of packages and packaging, from string bags to transparent wrapping, but the perfect apple package has yet to be found.

Better Packaging Consumer packaging is unsuited to the normal packing house, which is laid out specifically to handle large numbers of a single-sized bulk package, and is a nightmare to the packing-house manager, who seldom has any grader capacity to spare. Where large numbers of consumer packages are filled it has at present to be a separate operation in a separate building, the sorted fruit coming from the appropriate bins on the graders.

New machinery, however, is now being made that will pre-package apples into transparent film bags holding 4, 5 or 6 lb., and it is quite possible that one girl will be able to pack the equivalent of 800 bushels a day. The film bags will then be packed into a carton. To anybody who has fiddled with small cardboard divided containers (which never seem to be the right size), it sounds an attractive proposition. Apples look nice even when "jumble" packed in film bags, and if the cartons are handled properly the apples should travel all right. I think American apples might stand up to it, but it is doubtful if our own, rather softer, varieties would do so ; although surely in time it should be possible to get perishable products handled properly here.

Apart, then, from completely new methods and machines for packaging, which are as yet of the future, there is nothing new in principle in the present up-to-date American packing-house, though naturally great improvements have been made in detail in all their various handling machinery. The only real breakaway from the past is found in those few new houses that have adopted the fork-lift truck, and have "palletized" their whole operations. This really does produce amazing results in the saving of man-power, and anybody building new packing-houses or stores would be very foolish not to make them adaptable to a pallet system. At present the price of pallets—up to £4 each in this country, as against 15s. in America—makes it a rather hopeless proposition for our industry ; but doubtless this position will change in time.

Successful experiments have been carried out with disposable pallets made of fibre-board, and in time fruit may be handled entirely on pallets from the trees to the retailer's shop. Metal or wooden pallets would be used until the fruit is packed, then disposable pallets until it reaches its final destination.

Although they have been used for a number of years in the citrus industry, mechanized dumpers are just beginning to appear in the bigger apple packing-houses. I think they handle the fruit very carefully and I do not question the claims that they increase grader output by over 10 per cent. It is likely that they will come into common use, particularly as they fit in extremely well with the use of pallets. The combination again gives a great saving in man-power. One man can feed two big graders, including getting the apples from the reception shed. Fairly large outputs are required, however, to justify the capital cost of such equipment—250,000 bushels and upwards.

The only new package which took my eye was the moulded egg-carton type adapted for apples. This is constructed to take the normal apple counts of the diagonal box-pack, and I believe would be an ideal box for us to use for dessert apples. We are trying to arrange for it to be manufactured in this country so that it can be given a trial this season.

A good many sheds are now equipped with overhead hanging conveyors for empties, and all users say they are most efficient and practical.

Growing and Packing Costs Packing costs in the Pacific North-West have not increased in quite the same proportion as growing costs, but they still are very substantially higher than pre-war costs. The following gives an idea of the present position :

Box	$.3000	
Lids	.0440	
Pads	.0200	
Wraps and liners	.0700	.4340
Box-making labour		.0250
Labour		.1606
Overheads		.3700
Selling		.1000
Storage		.2000
		$1.2896

Growing costs for the 1948 season have been estimated at $1.70, of which approximately half is for labour. This gives a cost of practically $3 for the fruit packed ready for shipment. Refrigerated rail charges to eastern markets are $1.25 per box, so that a bushel box landed in, say, New York carries a total cost of $4.25.

The growing cost of $1.70 shown above was an estimate given me for the 1948 crop (a short one). No detailed costs for 1948 were available at that time, but British growers will be interested in the following Table showing how the growing costs of their opposite numbers have increased between 1940 and 1947.

Cost of Producing Washington Apples per acre—Yakima-Wenatchee Districts

(Compiled by Washington State College, Bulletin No. 493)

	1940	1947
	$	$
Pruning	4.91	44.25
Brush removal	1.16	7.23
Fertilizer	9.96	40.98
Applying fertilizer	.72	5.85
Cultivating and ditching	1.88	6.42
Irrigating	6.65	26.41
Spray materials	33.78	86.36
Applying spray	27.14	44.84
Thinning	18.05	53.68
Propping	2.45	10.07
Cleaning up	.29	5.79
Repairs	18.77	55.92
Gas and oil	4.62	12.99
Water costs	3.32	6.56
Taxes	4.20	8.60
Interest	17.00	80.10
Depreciation	9.00	35.95
Picking	35.63	90.33
Hauling and scattering boxes	10.10	7.76
Hauling fruit	7.44	30.46
Miscellaneous	10.34	94.74
	$227.41	**$755.29**

Cost per Bushel Box

Production cost per box	.556*	1.42†
Cost of packing, storage, marketing	.64	1.29
Average cost per box f.o.b. cars, Yakima-Wenatchee	$1.196	$2.71

* average per acre yield 1940—409 boxes.
† average per acre yield 1947—559 boxes.

No comparative figures of growing costs have as yet been compiled in this country. My guess is that they would work out rather lower per acre—about £125-150—and rather higher per box—about 10s. 6d.—due to the smaller average production per acre in our climate.

Packing costs are more difficult to compare. Our pre-war costs for packing and storage were 3s. per box, and our 1948 cost was 4s. 1d. The latter figure includes non-recurring items of 5d., e.g., for initial depreciations. But in this case we cannot compare like with like, as no proper box packing is possible nowadays. If it were, the cost of packing and storage might work out around 6s. 8d. per box. The only conclusion I can draw from these figures is that while our growing efficiency is the equal of the Pacific North-West, our packing efficiency still lags behind. This is not to be wondered at, since, owing to the war, the equipment of our packing-houses is ten years out of date.

Packing-house Labour If, however, packing-house outputs of half a million boxes and upwards are necessary to achieve comparative efficiency, then it is doubtful if we are in a position to compete. In America there is a large floating population of packing-house labour that follows the crops from South to North, and this labour can be used most of the year. The rest of the labour staff consists of local men and women. There is a tradition built up of turning out to help with the fruit crops on which so much local prosperity stands. While we have no floating population of professional packers to help us out, I do think we could build up a body of people who perhaps do not normally go out to work and who might enjoy turning out for our peak periods. But what to do in the off-season with the rather large permanent staffs that will be required for the big packing-house is a very knotty problem indeed, and one that may quite well mean that the very large, central packing-house is unsuited to this country.

Producer Co-operatives Regarding producer co-operatives packing and marketing concerns on the Pacific Coast, it is difficult to imagine the growers' plight had they not been so successful. They have been of tremendous benefit in protecting growers from excessive packing charges and in ensuring that growers get a fair deal in selling. They have had their ups and downs but are now securely established. They have grown from the bottom up, adapting themselves to their local growers and conditions. Their problems and ours are all the same and all different. There is no one set of rules applicable everywhere or any easy path to success ; each co-operative group has got to meet their problems and solve them as they go along to suit their own particular conditions. I feel sure that there is a big future for producer co-operatives in this country, and that acting together they can and will do as good a job for growers here as has been done by their opposite numbers abroad.

THE GLASSHOUSE BOILER

Contributed by the MINISTRY OF FUEL AND POWER

ALTHOUGH summer is still with us, farmers and glasshouse growers are no doubt already thinking about their heating plant and fuel supplies for the coming winter. Everyone is eager to obtain maximum results at the lowest possible cost, but it is not generally recognized how often this is frustrated by failure to give proper attention to a few simple points.

To help the grower in this respect, let us begin by asking two questions : (1) Have you examined your boiler plant while it has been out of use ? (2) Are you satisfied that you are getting full value out of the fuel you are burning ?

The two outstanding problems arising from the present fuel position which cause most concern to consumers are the comparatively high cost of fuel in relation to other charges, and the increasing difficulty in obtaining the most satisfactory grade of fuel. The latter alone can increase the fuel bill. Everything possible is being done to improve the position in these respects, but there is no universal remedy. This article, however, indicates some of the ways in which the cost of heating may be reduced without substantially increasing other expenses. More or better fuel cannot always be authorized, but the Horticulture Officers of the National Agricultural Advisory Service, or the Ministry of Fuel and Power, can advise you how to improve the efficiency of heating plant so as to obtain more heat in the right places for the same money—or the same heat for less money.

Even the best equipment cannot continue indefinitely to give maximum service without regular overhaul ; without it, the efficiency of the plant inevitably declines, major faults develop and ultimately there is a complete breakdown—usually at the most inconvenient time. This is as true of heating plant as of every other kind of machinery, and the obvious time for overhaul is during the summer months when the plant is not in use.

The total quantity of fuel of all types consumed by the agricultural industry is estimated to amount to some 1,500,000 tons per annum. Some of this is liquid fuel, used in internal combustion or diesel engines for threshing and ploughing, and some is solid fuel used in drying kilns ; but about 1,000,000 tons of solid fuel a year are used to fire boilers, mainly of the sectional or tubular types, although Lancashire boilers are in use in some places and locomotive-type boilers are doing general duty on many farms.

If the efficiency of all these boilers could be raised by even 10 per cent, 100,000 tons of fuel per annum would be saved for other purposes—a very useful economy at the present time and (what is probably of greater personal interest to growers) the fuel bill would be reduced by 10 per cent. This is a very modest estimate of the saving which could be achieved merely by giving proper attention to the maintenance of the heating plant.

Simple Overhaul As soon as possible after the end of the heating season a few simple measures should be undertaken to prevent or arrest deterioration, which is more liable to occur while the plant is out of use. If these precautions have not already been taken, no further time should be lost. These are the steps to be taken :

1. Completely withdraw all clinker and partly burnt fuel.
2. Empty the ash-pit.
3. Clean the smoke-tubes and chimney to remove all soot and grit.

Failure to attend to these points will inevitably result in the formation of corrosive acids by the chemical combination of the sulphur in the fuel residue and in the ashes with moisture in the air. Such acids will eat through the pipes, firebars and ash-pan.

Having thoroughly cleaned the fire side of the boiler, leave all the doors and dampers wide open to promote the free circulation of air, which will

prevent condensation of moisture from the atmosphere and thereby help to prevent the formation of corrosive acids.

The water should not be drained from a circulation system unless essential for the purpose of repair or occasionally for clearing the boiler of any accumulated sludge. The addition of fresh water should be limited to "topping up," since, particularly in hard-water districts, all fresh water added causes an increased deposit of scale on metal surfaces, which, by acting as an unwanted insulator, retards heating and consumes more fuel.

Finally, lubricate all moving parts, such as door hinges and damper controls, and see that they move freely ; paint or whitewash all exposed surfaces as a protective measure and cover all machined surfaces with grease to prevent rust.

Having halted deterioration by the foregoing means, a critical examination of all components is next desirable for the purpose of ascertaining damage done during the previous heating season as a preliminary to carrying out necessary repairs. The following are points which need special attention :

1. Replace any broken or warped firebars. The gap between bars is properly proportioned by the manufacturers to allow air for combustion to pass through the fire-bed while preventing partly-burnt fuel from falling into the ash-pan. Faulty bars will increase the width of this gap and cause loss of fuel, too much air where it is not wanted and, in consequence, waste of heat.
2. Renew any lagging which has been damaged. Lagging is put on the boiler and pipes to conserve heat and to concentrate it where it can be used. Unlagged surfaces therefore waste fuel.
3. Seal any leaks at joints, including the grouting round the base of the boiler All air for combustion must be under damper control. Even leaks in jointing on the chimney side of the boiler are harmful because they allow cold air to enter the chimney and thereby reduce the draught. All joints and brickwork can be tested with a lighted candle while the boiler is in operation. Where there is a faulty joint the flame of the candle will be drawn inwards.
4. See that the furnace doors fit snugly and that the refractory lining of the door is undamaged. A badly-fitting door will admit too much air, and damaged linings will cause the door to warp through overheating.
5. Examine all boiler fittings to make sure they are reliable. Check the response of the primary damper and the chimney damper. Make sure the safety valve (if fitted) is seating properly and is loaded to the correct pressure. See also that the thermometer is in working order and does not need replacing.
6. If automatic firing is used, whether for solid or liquid fuel, the firing equipment should be overhauled.
7. Examine all pumps, valves, air releases, etc. on the heating system to make sure that they are in proper working order.

When you are satisfied that the heating system is in good condition clean out the boiler-house and give it a coat of whitewash. Nothing fosters neglect more than dirt and untidiness. Even when you have restored the plant to proper working condition it is still necessary to consider its operation, for all that you have gained from careful maintenance can easily be lost if the plant is not operated correctly.

The Ministry of Fuel and Power issues a number of helpful publications which can be obtained free of charge on application to its Regional Offices. Bulletin No. 46, *How Glasshouse Growers can save Fuel*, is particularly recommended. Another useful pamphlet, *The Stoker's Manual*, can be bought for 6d. (8d. by post) from H.M. Stationery Office and gives much useful information designed to enable the stoker to obtain the best results from the plant.

Finally, if there is any problem in relation to plant maintenance or operation not covered in the foregoing brief notes or in the Ministry's official publications, a note to the N.A.A.S. Horticulture Officer or to the

Fuel Engineer at the nearest Regional Office of the Ministry of Fuel and Power will bring all possible technical assistance to ensure that the maximum results at least cost are obtained from the grower's heating equipment.

HOARY PEPPERWORT IN HERTFORDSHIRE

H. W. GARDNER

Institute of Agriculture, St. Albans

HOARY pepperwort has been a serious weed in Hertfordshire for many years. Publicity was first given to it at the County Show twenty-five years ago, and it has been featured, almost *ad nauseam*, at nearly every show since that time. It was hoped that by this continuous publicity the farmer would become familiar with the weed and dig it out before it got a hold ; the rapid spread of its underground root system soon makes forking out impossible. Numerous embryo infestations have been dealt with in this simple way.

A thorough survey of the distribution of pepperwort in Hertfordshire has never been carried out, but it is common from the south-west border near Rickmansworth up to Letchworth in the North. It is not confined to any particular soil type—severe infestations are known on gravelly loams, sandy loams, chalky loams, loam with flints, and on medium-heavy types of boulder clay. Professor G. E. Blackman, in the April, 1949, number of this JOURNAL, has described it as one of the worst pests over considerable areas of heavy clay, particularly in the South-East of England. It is clear, therefore, that pepperwort can become a menace on all kinds of soil from light to heavy. The most seriously infested area in the whole of Hertfordshire is shown in Plate 1, a photograph taken in a field of winter wheat in April, 1948, when experiments were being started for the eradication of pepperwort. The soil in this case is of the glacial sand and gravel formation, and the field lies just north of the point where the Great North Road, A.1, crosses the River Lea, not far from Welwyn Garden City.

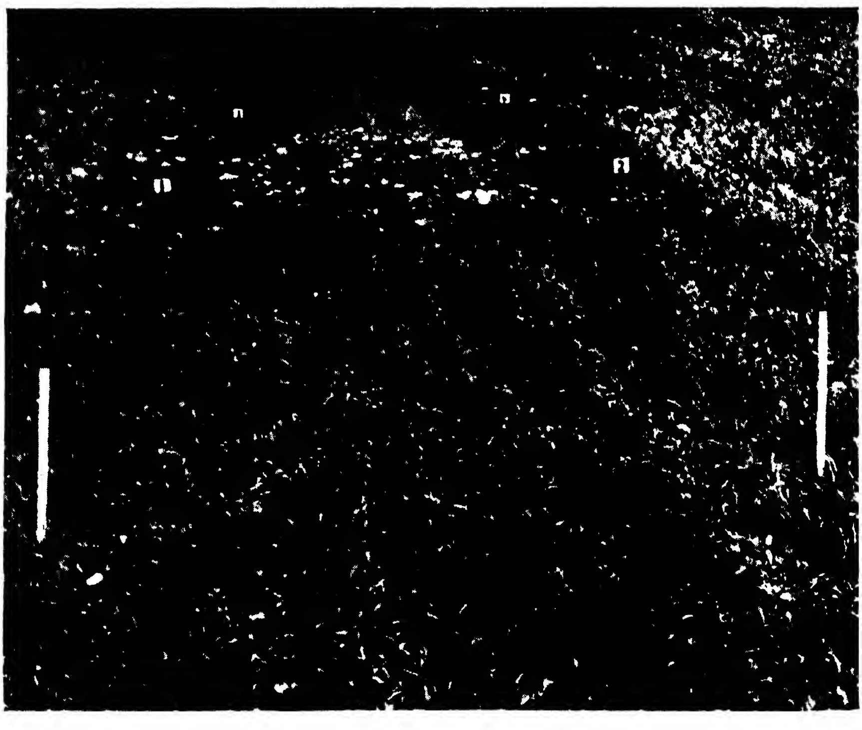
Another area where the infestation is almost as bad lies north-west of Hertford, on medium heavy soil of boulder clay. An impression of the density of the weed growth in this area can be obtained from Plate 2, which is reproduced from a photograph taken in 1926, shortly after the application of a sodium chlorate spray.

Pepperwort, besides being well established on many cultivated fields, is also prevalent on numerous rubbish dumps, some railway goods-yards, and in miles of hedgerows. Plate 3 shows a very vigorous growth on the verges of the main approach to Letchworth from the Great North Road. This was used as a tank depot during the war, has since become derelict, and is now a fruitful centre for the dissemination of the weed throughout the locality.

1. Infestation of winter wheat on glacial gravel near Welwyn Garden City (April, 1948).

2. Heavy infestation on boulder clay near Hertford. Photograph taken in 1926 shortly after sodium chlorate solution has been applied on left half.

3. Pepperwort on a former war-time tank depot near Letchworth.



4. First trial with MCPA (3 lb. per acre) applied April, 1945, in powder form. The control plot is between the numbered laths, with the treated plot in the foreground.

5. The plot on the left was treated with MCPA (4 lb per acre) as a spray. Photograph taken shortly after application in April, 1948.

Photos: *H. W. Gardner*

6. In May, 1949, only a few plants survive on the right where MCPA (2 lb [illegible]

THE USE OF RECORDS IN BREEDING DAIRY CATTLE IN DENMARK AND THE NETHERLANDS (See pp. 255-259)

1. Red Danish cows.

2. Dutch Friesian cows

Control By suitably planned rotations it is possible to keep the weed in check but extremely difficult to eradicate it (except from small areas as already mentioned). The rotation must include a large proportion of spring crops and, as was pointed out by Professor Blackman (*ib.*), satisfactory seedbeds for these are not easily prepared on heavy soils. On medium to light soils, however, by switching over mainly to spring crops (and the introduction of high-yielding spring varieties makes this possible for wheat as well as other cereals), the farmer should just be able to hold his own without the use of a weed-killer.

In the 1920s many experimenters tried the weed-killers in common use at that time—copper sulphate, iron sulphate, ammonium sulphate, etc.—in the hope of controlling pepperwort. In Hertfordshire, as in other counties, it was found that sprays made up from these materials severely checked the stems and so prevented a great deal of seeding, but, later, shoots grew from lower down and the total effect was disappointing. There can be little doubt, however, that such sprays, combined with the adoption of the right sort of rotation, would have been of considerable help in the battle against

the pest. But the scarcity of sprayers and the problem of the hundreds of gallons of water needed (as well as the economic conditions prevailing at that time) were too heavy handicaps against their use.

In 1925 Mr. C. E. Hudson and I started experiments with sodium chlorate as a weed-killer. At that time its possibilities had not been appreciated in this country and no cheap source of it was known. The first weed attacked, with very promising results, was the wild onion, and the following year it was also tried for cleaning bare fallows, for charlock and for pepperwort. These trials showed that eradication of pepperwort with chlorate was a possibility if persisted in over a number of years but, owing to its drastic effect on crops, was not a practicable method. All weed-killers are "selective" in the sense that different minimum amounts or concentrations are needed to kill different plants, but the range of "selectiveness" of sodium chlorate is not a convenient one for the eradication of weeds in farm crops : for example, 5 lb. per acre of sodium chlorate will kill charlock or ragwort, but even this small amount can do severe damage to cereals ; docks may be resistant to 80 lb. per acre.

Hormone Weed-killers In 1945 supplies of MCPA (then called CLC) were made available to County W.A.E.C.s for demonstration purposes, mainly on the control of charlock. After the main demonstrations had been begun in Hertfordshire, trials were also started on their use for pepperwort and buttercups. It was realized that as charlock and pepperwort were members of the same family, and as the hormone could be incorporated with a dry filler and applied with a fertilizer distributor, there was, at last, a good chance of opening a winning offensive against the pepperwort pest.

The trials in 1945 on two farms were very successful—perhaps encouraging is a better term, since with a weed like pepperwort observations over several years are necessary to measure the degree of success. Two plots at one centre are shown in Plate 4. The control is between the numbered laths, and in the foreground is the plot which was dressed with powder at the rate of 3 cwt. per acre (=3 lb. of the hormone) on April 11.

On the other farm approximately 100 per cent kill of pepperwort was obtained in the year of application with 3 gal. per acre (3 lb. of the hormone) of the commercial product diluted to 100 gal. and about 80 per cent with 3 cwt. of the powder form. In this case the farmer was so impressed with the results that he has since made it a regular practice to go round his fields with a supply of the powder, applying it wherever a plant could be found. He has now practically eradicated it from his farm.

Unfortunately, the observations planned for 1947 on the trials started in the previous year could not be carried out, and it was not until the spring of 1948 that another experiment was started. The site chosen was that shown in Plate 1, the field in that year carrying winter wheat. MCPA was applied at two different rates both in the two different forms, liquid and powder ; the plots were made large enough to be sub-divided with a view to repeating the dressings if necessary in the following year, and the treatments were replicated.

Detailed observations on these and other plots have been made and will be included in a subsequent article, but the very striking results obtained will be apparent from Plates 5 and 6. Plate 5 shows the suppression of the pepperwort by 4 gal. MCPA solution (4 lb. per acre of the hormone) soon after application in 1948. In the following year, 1949, barley was sown and, as would be expected from a spring crop, the general infestation was not so outstanding. This can be seen on the control plot on the right of Plate 6,

which shows the effect of 2 cwt. of the powder (=2 lb. per acre MCPA) *applied a year earlier*. A picture of this kind is an excellent corroboration of the conclusion tentatively reached in 1948 that a farmer, by adopting the policy of a sequence of spring crops plus annual treatment with a hormone dressing, could, in the course of three or four years, practically eliminate the weed. *Although the application of a powder is less efficient than a wet spray, yet, as Plate 6 illustrates, the powder can be extremely effective and is a method any farmer can adopt.* By persistent use of the hormone the few survivors from one year will be further reduced the following year.

Further experiments are in progress comparing MCPA and DCPA at different rates per acre and in wet and dry applications. There is, however, no necessity for any adviser to await the results of more trials. He can confidently go ahead urging the farmer to tackle the infested fields, on the heavy land adopting the policy advocated by Professor G. E. Blackman, and on medium and light soils that suggested above. County Agricultural Committees, in conjunction with Local Authorities, would also be justified in attacking the weed on waste places, refuse dumps, hedgerows and the numerous other centres acting as sources of reinfestation. Pepperwort has been on top for many years : it is full time it was suppressed, and the means are now available for doing so.

LANDOWNERS' COURSE IN ESTATE MANAGEMENT

THE HON. ANTHONY STRACHEY, M.A.
Central Landowners' Association, Somerset

A THREE-DAY refresher course in rural estate management was organized by the Central Landowners' Association at the Royal Agricultural College in April. Sixty-five members of the Association attended, and the course consisted of seven lectures, interspersed by visits to seven farms in Gloucestershire and Wiltshire to inspect buildings and systems of husbandry.

Four of the seven lectures dealt with the economics of rural landowning, as affected by taxation, rents and recent legislation. Two dealt with the problems of the maintenance and improvement of fixed equipment on the land, such as farm buildings and farm roads, and the last, given by the President of the Association, Major R. G. Proby, dealt with The Future of Private Landowning and some of the imponderables, political, economic, as well as agricultural, which inevitably impinge on this topic.

All parts of England and Wales were represented at Cirencester, and it quickly became obvious from the discussions after the lectures and the comments made on the farm visits that what is common sense in one part of the country may well be nonsense in another ; a method of farm building suitable for Gloucestershire farming may be quite inapplicable to Cumberland ;

a method of road-making that is the cheapest in Somerset might be the most expensive method in Hampshire; the best solution to a problem of estate finance in one set of conditions might be quite impracticable in another. Thus one of the outstanding lessons of the course was that while technical knowledge of the requirements of modern farming is important to good estate management, there is a great danger in theories and generalizations not based on an equally sound knowledge of local conditions and traditional methods of dealing with local problems.

An added complexity in dealing with estate management policy in general terms is due to the diversity in size of estates and type of rural land tenure. The sixty-five landowners attending the course themselves represented holdings ranging from 5 to 50,000 acres. Some were farmer-owners; some traditional estate owners whose land is managed on the landlord and tenant system, and on which timber production plays an important part in the estate economy; some were both landlords and owner-occupiers in varying degrees of emphasis.

Economics of Land Ownership But dominating all the subjects discussed and overriding the diversity of local agricultural conditions and type of land tenure was the problem of economics. It was a thread running through all the lectures—the ability of the rural landowner to carry out all his duties and yet remain solvent. It was mentioned by the Chairman of the Association, Lt.-Col. W. R. Burrell, in his opening remarks and by the President in his final address. It constantly recurred during the farm visits, when guides were closely questioned about costs of construction and the labour-saving effect of alterations. Significantly the opening lecture was entitled "The Influence of Taxation on Landownership Policy"; it was given by Mr. W. Walker Watson, an able accountant who has specialized in rural estate finance. But the subject loomed equally large in the next lecture entitled "Farm Rents and the Rate of Interest on Improvements"—a subject that was covered comprehensively by Mr. Charles Walmsley, author of the recent publication, *Rural Estate Management*.

But perhaps the most forceful example of how economics linked the outlook of all the speakers came in the opening remarks of Mr. N. Dean of the Cambridge University Estate Management Department in his lecture, "Farm Buildings—Their Design, Methods of Construction, Adaptation and Repair"—a subject on the face of it dealing more with construction than finance.

"Under existing conditions," he said, "with building costs at least five times those ruling in 1914, and agricultural rents in general not very much above 1914 levels, however much advice they receive landowners find great difficulty in carrying out repairs essential to prevent further deterioration, much less improve their buildings or provide new ones. We now have the ridiculous position of the cost of replacement of farm buildings considerably exceeding the freehold value of the farm. Under these circumstances it seems to me that the most useful advice which could be tendered to landowners and their professional advisers at the present time is 'How to get a quart out of a pint pot'—and I wish I knew the answer. In other words, the problem is one of economics; and until agricultural rents are raised to figures more in keeping with present-day values, there seems to me little point in discussing model new homesteads."

Against such a background, Mr. Dean dealt with the best ways of repairing and reconditioning to increase efficiency at the lowest possible cost. As regards a farm building policy, in his view "the most useful thing that can

be done at the moment is to avoid expenditure on new buildings of a highly specialized character which cannot readily be adapted for other purposes should the system of farming change." Such adaptability, he believed, would be promoted by bearing in mind certain "master dimensions" for all buildings.

Of very considerable interest was Mr. C. Walmsley's discussion of the theory and practice of various conceptions of rent, and here he stressed the importance of the owner-occupier maintaining in both his mind and his accounts a true distinction between his capacity as owner and his capacity as occupier, if he wished his records to be other than "incomplete and misleading".

Concerning "fair rents," he said: "How can one achieve a stable rent on a basis acceptable to the tenant and fair to the landlord? The ideal approach is certainly to look at each holding, not as it exists now, but as it should be, equipped so that a first-class tenant can obtain the maximum sustained productivity at the lowest cost. This approach involves carrying out an improvement survey to ascertain what is really needed . . ." Having gone into some detail about the improvement survey, Mr. Walmsley commented sadly: "Many land agents would agree with the principle of the improvement survey. Few indeed, at this particular time, could treat it as more than a counsel of perfection," for the reason that "a land agent's day is so fully occupied with the machinery of routine management and with picking his way through the jungle of recent legislation". None the less he strongly advocated such a survey where possible.

It was with this "jungle of recent legislation" that the next two lecturers dealt: Mr. F. G. Holland, solicitor and assistant secretary to the Association, in "The Town and Country Planning Act, 1947: The Land, the Act and Estate Finance," and Capt. E. H. Mostyn of the Agricultural Land Service, in "Some Aspects of the Agricultural Holdings Act, 1948". Mr. Holland pointed out that while the planning Act had, through the development charge, nationalized part of the financial resources of an estate, the agricultural development of an estate was largely unaffected, except that planning permission would be required. Capt. Mostyn was equally informative in helping his audience digest the effect of recent legislation on the traditional relationship of the landlord and tenant. While the tenant's position had been strengthened, his liabilities, both in regard to repairs and standard of farming, had been increased. Agreements were now made to be complied with by both parties.

The lecture on The Maintenance and Improvement of Farm Roads by Lt.-Col. H. A. Sawyer contained much useful and practical material, and the discussion that followed showed just what a burning question this subject is to many landowners. Space allows only a mention of the speaker's graphic rule-of-thumb for farm road economics—"Sufficient unto the strength is the expense thereof".

Farm Visits Farm visits included those to the Royal Agricultural College, under the guidance of Professor R. Boutflour, where detailed costings were given showing the financial results of the systems of dairy husbandry employed. As with the other farms, the emphasis was on milk production. The other six farms were visited under the guidance of Mr. N. E. B. Elgar, South-West Provincial Farm Buildings Advisory Officer. (It should be mentioned in passing that Mr. Dean had in his lecture exhorted both the industry and the professions to encourage specialization on farm buildings.) The yard-and-parlour system was much in prominence. Costs given for erection of new buildings on this system at two of the farms visited worked out at £40-£45 per cow, which compares favourably with new

cowhouses at present costing between £50 and £60 per cow. Other items of interest included: ingenious uses of scrap materials, methods of controlling feeding of yarded cattle (still in the experimental stage), buildings for grass and grain driers, and construction of labour-saving bull, cattle, and calf pens. While admiring the pioneering inventiveness of such milk producers as Major J. Lowsley-Williams of Manor Farm, Tetbury, Glos, visiting landowners were most interested in the capital outlay, the adaptability of buildings, and their likely length of service.

The members attending the course dispersed with much food for thought. It is clear that landowners have an essential part to play in the expansion of agriculture; their role, either as landlord or farmer-owner, is neither simple nor passive. The rural landowner has a multitude of calls on his time and pocket; his obligations to the State are heavy, and the technicalities of his business are complicated by legislation and State policy. But as the President of the C.L.A. reminded his listeners in his closing address, though much is expected of the landowner in local and public affairs, he must first of all strive to remain solvent if he is to be of use either to the community or to his dependants. So in the words of Voltaire, "'Cela est bien dit,' répondit Candide, 'mais il faut cultiver notre jardin'."

HOME-MADE POULTRY HOUSING

J. B. Thorburn
Bridport, Dorset

It is possible that many general farmers are deterred from expanding poultry production by the high cost of poultry houses. Prices are now about five times as much as before the war, and this means a considerable capital expenditure to accommodate a fair-sized flock of hens.

Existing farm buildings can sometimes be used, but only to a limited extent if it is intended to run the birds on free range. A large flock of hens roaming the farmyard can be a nuisance, and the risk of disease is increased when the birds are concentrated on the same piece of ground year after year.

If good use is to be made of the natural food found on leys and stubbles and if hens are to contribute to the fertility of the land by their droppings, movable free range houses must be used. The manufacturers of poultry houses offer a wide choice, but home-made houses can be made for a fraction of current prices if, instead of buying new timber, alternative materials are used and there is a man about the place handy with carpenters' tools. Recent developments in poultry-keeping have shown that the hen is far less conventional about the kind of accommodation she requires than was once thought. Poultry do require dry, well-ventilated but draught-proof houses and sufficient room for each hen to roost comfortably. Given those essentials, the birds will thrive in a wide variety of housing conditions.

The house must be movable, which means that wheels or skids must be provided. Where a tractor is available for moving, skids are the more satisfactory, and they are cheaper because suitable wood can often be found on the farm.

Next comes the floor. Although a solid floor is ideal, one can be made of slats upon which the birds will roost, or it can be omitted altogether if perches are fitted. Wire netting fastened across the bottom of the house will safeguard the hens against foxes. Rats may be a nuisance but they seldom attack adult birds.

For proper comfort each hen requires nine inches of perch space or one square foot of slatted floor. It is advisable to give them as much space as possible, because overcrowding will reduce egg production. A slatted-floor house to hold 50 hens ought to be about 8 feet × 6 feet ; if perches are used, rather bigger.

The walls and roof of the house can be made of any material which is weatherproof. Hens do not need much head room. The old-fashioned poultry house was always made sufficiently high to enable a man to enter it for cleaning. Cleaning is always necessary, although with the slatted-floor, or no floor, type of house which is moved frequently on to fresh ground, it can be reduced to a minimum. For example : it is quite simple to make the roof detachable or to work on a slide. Alternatively, one of the side walls could be made detachable.

Timber for the framework cannot be bought new (except under licence), but it may be cut from a coppice or, more likely, obtained from disused equipment. The writer made some serviceable poultry houses out of old A.R.P. folding beds, and there are many other surplus wooden objects about these days. The framework may be covered with roofing felt or thatching straw as protection from the weather, wire netting being superimposed. Galvanized iron or aluminium alloy sheet are, of course, more durable but more expensive. When making the roof it is important to provide good and draught-free ventilation. During a long winter night hens, crowding together for warmth, consume a great deal of oxygen, and unless the air in the house is renewed frequently their health will suffer. They can endure very low temperatures, provided there are no draughts.

Orange crates make good nest-boxes. They are so good that they might almost have been designed for the purpose and, being cheap, they can be renewed frequently. It is advisable to fit them with a simple closure to prevent the hens from roosting in them at night.

Parts of old aeroplanes, pontoons and boats, old vans and even the bodies of derelict tramcars and railway carriages have been used for making poultry houses. With a little ingenuity and labour—at quiet times of the year or during bad weather—such material can be converted into useful, and not necessarily unattractive, housing equipment for the additional poultry the country needs so much.

FARMING AFFAIRS

Hill Farming Land Improvement Progress

Substantial progress is being made this year with the improvement of hill farms in England and Wales with the help of grants under the Hill Farming Act. These grants, which amount to one-half of the cost of the work done, are given to owners and occupiers of hill farms who are willing to carry out schemes approved by the Minister of Agriculture and Fisheries for the improvement of their land. Schemes may cover as many as twenty-three different kinds of improvements, e.g., the repair and modernization of existing farm houses, cottages and farm buildings and the building of new ones; work on roads, bridges and water and electricity supplies; the improvement of grazings, drainage and fencing; and the planting of shelter belts. They must be comprehensive—that is, they must include sufficient improvements to put the farm into a proper working condition.

By July 31, 1949, 123 schemes had been approved and were in operation, and 2,034 proposals for schemes were under consideration, making a total of 2,157 "live" schemes. 1,379 of the 2,034 proposals (about 64 per cent) had been approved in principle and were awaiting the preparation of formal schemes for approval. Work had actually been started on 761 schemes still awaiting formal approval.*

The 2,157 "live" schemes relate to 2,657 holdings, with a total area of about 864,000 acres, and represent about 17 per cent of the total number of hill sheep farms in the country. Although the total cost of the work under the schemes is at present estimated at about £2,393,000, it will probably prove to be considerably higher, principally because the preliminary proposals are often extended to cover more improvements by the time the scheme is formally approved. The main improvements are those to farm buildings (£475,000, or 20 per cent of the total), farm houses and cottages (£337,000—14 per cent), improvement of grazings by manuring, reseeding and laying down of permanent pasture (£360,000—15 per cent) and work on fencing (£229,000—10 per cent), roads and bridges (£162,000—7 per cent), water supplies (£98,000—4 per cent), electricity supplies (£91,000—4 per cent) and drainage (£106,000—4 per cent). Full details are given in the Table on p. 282.

The position at July 31 for England and Wales was as follows :

	ENGLAND	WALES	TOTAL
Schemes approved	37	86	123
Proposals approved in principle	379	1,000	1,379
Proposals under consideration	338	317	655
TOTAL "LIVE" SCHEMES	754	1,403	2,157
"LIVE" SCHEMES			
Total	754	1,403	2,157
Estimated cost†	£1,090,000	£1,303,000	£2,393,000
Number of holdings covered	1,028	1,629	2,657
Total acreage of holdings	358,000	506,000	864,000
Percentage of hill farms covered	14	18	17
Number of schemes awaiting formal approval for which work has been authorized	296	465	761

*See also paragraph 5. †See also paragraph 3.

Improvement schemes, which usually include a large number of individual items of work, are carefully considered on the spot, in consultation with the promoters, by officers of the County Agricultural Executive Committees and of the Ministry's Agricultural Land Service to ensure that they are suited to the requirements of the farm. Schemes, which require the Minister's formal approval under the Act before grant can be paid, are also considered at Ministry headquarters to ensure that they are dealt with as uniformly as possible. This necessarily takes some time, but no urgent work need be held up because a scheme has not been formally approved. Authority to proceed with it can be given by the Land Commissioners on the understanding that grant will be paid only if the work is done satisfactorily and the improvement is later included in an approved scheme. Work has already been started under this arrangement on 761 (nearly 40 per cent) of the schemes not yet approved.

Proposals for schemes are first approved in principle on submission of a list of proposed improvements, so that promoters may know whether their schemes are likely to be eligible before going to any further trouble or expense in preparing them. When the proposals have been approved in principle, applicants are asked to submit the necessary documents for formal approval by the Minister. So that schemes may not be delayed until full technical details for all improvements are available, formal approval may be given on a general description of the work with a rough estimate of its cost ; in that case the necessary detailed specifications, plans and estimates are sent to the County Agricultural Executive Committee later when the promoters are ready to begin the work. Any applicant who has difficulty in drawing up his scheme may obtain guidance from his County Committee or the Land Commissioner on the understanding that he takes full responsibility for the scheme.

Some promoters are still taking a considerable time to prepare their schemes for formal approval after they have been approved in principle. This may be because they are experiencing difficulty in getting estimates from contractors. While estimates given in schemes should be as close as possible to the actual cost of the work, the Ministry realizes that they will often be only a general indication of the probable cost and, provided the plans and specifications submitted later indicate that the reasonable cost of necessary work will be more than had been expected, grant will be paid on the actual cost, even though it is higher than the estimate given in the scheme. If, therefore, contractors' estimates are not readily available, promoters should not hold up their schemes but submit them with a general indication of cost. Payment for work done in advance of the formal approval of a scheme cannot be made until that approval has been obtained; it is therefore in the promoters' own interest to submit his scheme as soon as possible.

Although the funds available for the payment of improvement grant for the whole of the United Kingdom may be increased by a further £1,000,000 with the consent of the Treasury and the approval of Parliament, they are at present limited to £4,000,000. Well over one-half of this sum has now been earmarked for schemes already received, even allowing for the present figures probably being low. Intending applicants should therefore not delay submitting their proposals. Full details and forms of application may be obtained from the Agricultural Executive Committees in hill farming counties, the Ministry of Agriculture, Hill Farming Branch, 14–21 Chester Terrace, Regent's Park, London, N.W.1, or from the Ministry's Welsh Department, 17 Eastgate, Aberystwyth.

Hill Farming Land Improvement Schemes in England and Wales as at July 31, 1949

Analysis of Proposed Expenditure

	ESTIMATED COST	PERCENTAGE OF TOTAL
Farm buildings	£475,449	20
Farm houses	224,223	9
Farm cottages	113,140	5
Roads, bridges	161,881	7
Water supply	98,229	4
Electricity	91,313	4
Pens, dipping accommodation	43,154	2
Silos	2,265	‡
Fencing	229,024	10
Grids	495	‡
Drainage	105,725	4
Reclamation of wasteland	11,777	‡
Shelter belts	37,627	2
Liming	68,733	3
Manuring, reseeding, permanent pasture	359,911	15
Removal of bracken	24,316	1
Machinery	5,055	‡
Pest destruction	938	‡
Unspecified (costs supplied relate to a number of improvements and no reasonable apportionment can be made)	339,998	14
	£2,393,253	100

‡less than 1 per cent.

World Food and Agricultural Science Sir John (now Lord) Boyd Orr was the first speaker at the International Congress on Population and World Resources in Relation to the Family (Cheltenham, August, 1948), the report of which has recently been published.* His subject was the world's food resources. He made two assumptions : that it is the duty of every Government to ensure the primary necessities of life for every family, and that we must regard all countries as having equal right to the primary necessities of food, clothing and housing—and by " housing " he meant not merely shelter but a house in a sanitary environment free from endemic disease. World population is increasing at the rate of 20,000,000 a year. By the end of the century it is likely to have increased from the present 2,000 million to about 3,000 million. " Can we stop the population of the world growing ? " While we talk of birth control, and migration, in Lord Boyd Orr's view the only way to get a static population is to raise the living standard of people and to spread education : then he hoped and believed there will happen all over the world what has happened in Western Europe—a fall in the birth-rate, and though the death-rate must fall too, we may hope to get a stable world population at whatever level is found to be most suitable.

Malthus (1798) affirmed that a stage would soon be reached when there was not sufficient food to feed the people of the world. It was therefore wrong, he suggested, to bring in measures for social amelioration, for preventing infant mortality and for keeping people healthy. They would only aggravate the problem. But Malthus did not forsee the great opening up of the western and southern hemispheres, which almost doubled the area of land capable of producing food, nor the advance of science. Today we cannot look forward to the discovery of any new land. All the land which can be easily brought into cultivation by existing methods has already

*H. K. Lewis. 10s. 6d.

been enlisted. During the second world war we added almost nothing, in spite of the great shortage of food. And all over the world much of the land is losing its fertility.

There are those who believe we cannot produce sufficient food to feed the World's people, but, said Lord Boyd Orr, they are not authorities on agricultural science. If the best cultivation, the best methods, the best seeds were used, it is possible that as much food as is being produced now could be produced on half the present acreage. In addition, lands which have become barren can be brought back into cultivation. In several parts of the world it has already been done by irrigation. " It is difficult to set limits to the amount of food which can be produced if we would apply science to food production with the same intensity that we apply science to destruction in war . . . The number of people we can feed and clothe and house is limited only by the amount of effort that Governments are prepared to devote to it."

It should be done, he said, not only for the benefit of the ill-clad, ill-fed people but for our own salvation. Malthus did not realize that people will not die quietly. People who are short of food, and especially people whose standard of living has come down, are not interested in anything else; they are not interested in political ideologies, but will follow anyone who will promise them food. In conclusion, Lord Boyd Orr made a strong plea for national co-operation in a world plan.

National Pig Starter Food The surest way of rearing pigs successfully is to start them well and get them through suckling, weaning and the trying period onwards to 12 weeks without a check to their health and growth. If this is done, they are able to deal with coarser foods at an earlier age, and finish out with better carcasses some weeks earlier than they would otherwise do.

In the absence of appreciable quantities of milk by-products there is a real need for a good pig starter ration.

To meet this need, authority has been given for the supply of special feed—*National Pig Starter*. As such, it is naturally intended to be used as a " creep feed " as well as for feeding during the first 10 days or fortnight after weaning. It is made under licence and sold at a controlled price. Its composition is safeguarded both for the quantity of its ingredients and for their quality. As required by the young pig, the total content of protein is somewhat higher than that of National Pig Ration No. 1. The animal and vegetable proteins in it have been chosen for their suitability, and special attention has been given to the inclusion of the necessary minerals and vitamins. The new National Pig Starter ration is a complete food for the young pig. However, when the litter is not running out-of-doors, it will still be advisable to dose the young pigs with iron during the third week after birth, in order to prevent the development of anaemia (see Animal Health Leaflet No. 1).

When applying, in the usual manner, to the County Committee for the farrowing allowance of 9 cwt. of feedingstuffs, pig-keepers will be asked to indicate on the application form (obtainable from the Committee) whether the preference is for the allowance in the form of 3 cwt. of National Pig Starter and 6 cwt. of ordinary cereals and proteins *or* the whole 9 cwt. in ordinary cereal and protein coupons (in the usual proportions). The former alternative is the recommended course. The coupons will be issued by the Committee in the usual way.

Special feedingstuffs coupons have been prepared for the National Pig Starter, and these are available only for that food. They should be deposited with the pig-keeper's suppliers, as with other feedingstuffs coupons, within 15 days of the date of issue.

It is a good plan to get piglings interested in solid food very early in life. Their appetites can be, and always should be, stimulated. Food goes twice as far before weaning, compared with the amount needed for each pound of liveweight increase between weaning and slaughter. Well-suckled piglings have better appetites than those poorly suckled, as they are putting on weight more quickly.

Left to themselves, young pigs will begin to eat the food in the sow's trough. But coarse, wet foods are unsuitable for little pigs and are apt to chill them. Shivering and indigestion cause set-backs. Piglings learning to eat do best on dry feeds given at short and definite intervals. Creep feeding is essential; otherwise, the sow will eat the piglings' special food.

Creep feeding is simple and inexpensive to arrange. It just means keeping the sow away from the piglings' food. A small trough in a corner of the sty, fenced by a strong hurdle is sufficient. It is well worth the small trouble involved, and ought to be a routine practice on every farm rearing pigs.

National Pig Starter should be offered dry to the young pigs by the time they are three weeks old. Give them small amounts two or three times a day. At first the piglings are likely to nose about in the food, but later on they should eat well over a pound a day per head

Water is essential and should be freely available, but the piglings should be prevented from wallowing in it.

As soon as the young pigs are strong enough they should go out for an hour or two every day to root in the grass. If the weather is bad, a sod or some fresh soil should be placed in the pen each day from the third day after farrowing.

Grain Storage With more and more corn being ingathered by combine harvesters, the problem of grain storage on the farm becomes greater and more widespread. A new Growmore Leaflet (No. 102), *Combine Harvesting and Grain Storage,** will, it is hoped, help considerably in this connection.

Four courses are open to farmers: storage in sacks, in heaps on the floor of buildings, in shallow bins not more than 4 feet deep, or in specially provided deep silos. The state of the buildings in which the grain is to be stored calls for special attention. The floors must be strong and impervious to moisture, the walls, also strong, should have a sound damp-proof course, and the roof should be watertight. Ventilation should be provided both near ground level and high up in the building.

Farmers with only a small acreage of corn for storage will find sacks stacked not more than four high, shallow bins, or even heaping the grain on the floor entirely satisfactory and cheap.

Shallow bins can be formed by using timber, concrete planks or slabs, bricks or corrugated metal sheets. If the floor is likely to become damp from ground moisture, either an impervious layer should be added to it, or a false floor, raised 3–4 inches, should be provided. If bins of this kind are at first-floor level, provision should be made for delivery by chute to the ground floor.

Deep bins or silos can be specially constructed in brick, concrete, or curved corrugated steel sheets; or prefabricated units may be bought from most concrete manufacturers. The choice between cylindrical and rectangular silos is not easy, but in general it is probably true that in first cost the cylindrical shape is slightly more attractive. Silos may be of any height up to 20 feet and diameter up to 14 feet, but, in silos of this size, there must

*Free and post free from the Ministry, 1 St. Andrew's Place, Regent's Park, N.W.1.

be some method of moving the grain by mechanical conveyor or by pneumatic elevators. Where the grain can be dried effectively before being stored, it is doubtful whether self-emptying bottoms to bins or silos are worth while on most farms, but some conveying system for filling and emptying is needed so that small pockets of grain tending to heat may be dealt with, by transfer of the grain from one bin to another.

If silos are placed in open-sided buildings, care should be taken to ensure that the walls of the silos will not absorb rain blown against them. It is an advantage if prefabricated concrete grain silos are of the " stave " type held in by stout wire ropes. This enables them to be dismantled and re-erected elsewhere without difficulty. A good arrangement for silos is to place them in a double line, so that they discharge by gravity into a central trench from which the grain may be conveyed mechanically or by pneumatic methods.

With either deep or shallow bins it is essential to have one extra bin so that, in case of need, grain can be moved at will from bin to bin. In deciding the number and capacity of bins required, the following figures of volume per ton will be useful.

Wheat	45 cu. feet per ton
Barley	50 cu. ,, ,, ,,
Oats	70–80 cu. ,, ,, ,,

The Farm Buildings Advisory Officer is ready to help with any problems arising from the need to convert buildings or construct new ones.

Guard specially against attacks by rats and mice. They will not be slow to take full advantage of an apparent bounty by the farmer !

Nature Month by Month—September There is a keenness in the air, these September mornings, and a diminution in active wild life that presages autumn. There is a settled quiet ; a seeming awareness of the passing of summer and a sense of waiting for the colder days to come.

Foliage is looking dingy, now, and here and there leaves are already browning at the edges. Wild flowers are fewer and the best are over, but in the gardens the mauve of the Michaelmas daisies is coming into prominence.

For most wild birds nesting-time has long passed, but even now a few pairs of wood-pigeons will be rearing their third or fourth brood The robins are singing their winter song, and the outward movement of the migrants is noticeable. Already the swifts have gone, and soon the swallows will be congregating on the telegraph wires and the railings near the farmhouse. There have been fewer swallows this season than I have seen for many years, although the house-martins seem to be well up to strength. Partridges are on the stubbles ; for the most part they avoid the root fields on the wet days.

The great red-underwing moths are out. At rest in the daytime, with folded wings, they are mere triangles of mottled grey on the willow trunks, so like the bark that they are very hard to find, but on walls and fences quite easy. On a railway bridge the other day I saw five of them in an area of not more than six feet by four. In the orchard there is a small heap of abandoned, rotting apples—a great attraction to the red admirals. In the garden there is a buddleia still in flower. If one but touches a branch of the shrub on a sunny morning there arises a cloud of butterflies—red admirals, peacocks, whites and others. Not for the first time I have noticed how the lure of the mauve blossom-cones of this buddleia is so much stronger than that of the orange globes of the other kind.

On the Moor the bracken is turning, although not yet will it assume that uniform rust-red that will be so marked in late autumn and early winter.

Our sandpipers have gone, and some of the curlews are visiting again their feeding haunts on farmland. Not for some time yet will the woodcock be in, nor the companies of golden plover.

The river, again, is low and sluggish, and most of the trout are keeping to the stickles and the rougher pool-tails. There is much weed in the quiet reaches.

Soon we shall have the first frost of autumn to mark more plainly the changing season. Meanwhile, to the outdoor man, September remains one of the best of all months in the South-West.

F.H.L.

Exmoor: Economic Survey The Exmoor hill district is a small isolated upland area sharply divided from the fertile vales of Williton and Taunton to the East and South, and clearly distinguished from the less hilly North Devon country which borders it on the South and West. The altitude is not extreme: very little of the area exceeds 1,500 feet, and the contour here used as a survey area boundary is 800 feet. In this part of England the mere temperature at such heights is not severe. The climatic difficulty is mainly humidity in the form of rain and mist, and this factor combines with stony soils from which lime is readily leached, and steep intersecting combes presenting obstacles to transport, to produce a distinct agricultural and social problem, which is the more obvious and clearly recognized because of the much more propitious conditions which are found so close at hand. Storm clouds over Exmoor are often visible for miles in several directions, and farmers in the vale are near enough to be well aware that hay is cut weeks later on the hill.

The idea of an economic survey of the farm land of Exmoor and the Brendon Hills arose out of a discussion between half a dozen members and officials of the National Farmers' Union and members of the Agricultural Economics Department of Bristol University, and the report*, built up from data supplied by 274 farm questionnaires, by the Department of Economics, Bristol University, will be read with interest by all concerned with the marginal farming areas of this country.

It is emphasized that this report does not pretend to supply an answer to the problem of the best use of the area under survey. Broad questions of policy which would have to be considered are quite beyond its scope, and even as an investigation of local conditions there are some relevant aspects upon which it touches slightly or not at all. The aim has been to make a factual contribution, presenting as fully as possible the financial information which is not to be had except through a confidential investigation by an independent body, and adding, to place this in its setting, some of the bare bones of a more general description of the situation. The interpretation is left to the reader.

The Marketing of Home-Produced Apples in England and Wales *Factors in the Marketing of Home-Produced Apples in England and Wales* (Economics Series No. 50) is the title of a new report issued by the Marketing Division of the Ministry. The report, which covers dessert, cooking, and cider apples, deals among other things with the imports and exports of apples and apple products, the utilization of home supplies, and marketing arrangements. The demand for and prices of market apples are also considered. The publication is available from H.M. Stationery Office, price 1s. 3d. (1s. 5d. by post).

*VERNON BAKER. *Exmoor: an Economic Survey.* University of Bristol. 5s.

COMMONWEALTH AGRICULTURAL BUREAUX PUBLICATIONS

The following is a list of journals and other periodical publications of the Commonwealth Agricultural Bureaux, with subscription rates. For journals marked with an asterisk a 20 per cent deduction is allowed to subscribers in the British Commonwealth who send their subscriptions direct.

Bulletin of Entomological Research	40s.
Review of Applied Entomology (Series A)	40s.
Review of Applied Entomology (Series B)	20s.
*Review of Applied Mycology	40s.
Helminthological Abstracts	35s.
*Animal Breeding Abstracts	35s.
Veterinary Bulletin	40s.
Index Veterinarius	100s.
Nutrition Abstracts and Reviews	63s.
*Dairy Science Abstracts	35s.
*Forestry Abstracts	45s.
Forest Products and Utilization	15s.
*Horticultural Abstracts	35s.
*Field Crop Abstracts	35s.
*Herbage Abstracts	35s.
*Plant Breeding Abstracts	35s.
*Soils and Fertilizers	35s.

A few notes on recent miscellaneous publications are given below.

Phenothiazine 1942-46 : *A Review and Bibliography.* (November, 1947) 4s.

A continuation by Edwards of the review by Davey and Innes (1942), together with a bibliography by the Commonwealth Bureau of Agricultural Parasitology in continuation of that published in 1942.

Pregnancy Diagnosis Tests : *A Review.* (September, 1948) 15s.

A survey of all important papers on the diagnosis of pregnancy in women and domestic animals, with the exception of those concerned with clinical methods in women.

Growth Substances and their Practical Importance in Horticulture. (1949) 12s. 6d.

A review of the actual and potential uses of synthetic growth substances in horticulture and the technical problems involved in their use.

Five Hundred Varieties of Herbage and Fodder Plants. (1948) 15s.

A compilation of information on crop varieties collected from many parts of the world, indicating the desirability of some attempt being made by research workers to achieve uniformity in regard to standards, nomenclature, synonyms, etc.

New and Promising Varieties Recently Described in the Literature (*7th* issue). (May, 1948) 2s. 6d.

The Practice of Soil Conservation in the British Colonial Empire. (1948) 10s.

This is the first detailed account of colonial soil conservation to be printed. The main conservation methods are classified and their effectiveness in different territories discussed. The control of grazing and livestock management and systems of colonial agriculture in relation to soil conservation are described. There are chapters on the use of machinery and aerial-photographic surveys, and an account of colonial legislation relating to soil conservation.

All correspondence concerning the above publications should be addressed to the Commonwealth Agricultural Bureaux, Central Sales Branch, Penglais, Aberystwyth, Wales.

THE MINISTRY'S PUBLICATIONS

Since the date of the list published in the June, 1949, *number of* AGRICULTURE (*p.* 136), *the undermentioned publications have been issued.*

Bulletins Copies are obtainable at the prices mentioned from the Sales Offices of H.M. Stationery Office or through any bookseller.

No. 113 Rhubarb (*Revised*) 1s. 0d. (1s. 2d. by post)

Technical Bulletin No. 1 : Specifications and Methods of Analysis for Certain Insecticides and Fungicides (*New*) 1s. 3d. (1s. 5d. by post).

Advisory and Animal Health Leaflets Single copies of not more than 16 leaflets (four in any one group) may be obtained, free of charge, on application to the Ministry, 1-3 St. Andrew's Place, Regent's Park, London, N.W.1. Copies beyond this limit must be purchased from the Sales Offices of H.M. Stationery Office, net price 1d. each (2d. by post), or 9d. per doz. (11d. by post).

Group I. Livestock and Dairying

No. 113 Rearing Fowls for Egg Production (*Re-issued*)
No. 341 Artificial Incubation (*New*)
No. 342 Housing Systems for Flocks on the Range (*New*)

Group II. Pests and Diseases of Farm and Horticultural Crops

(a) INSECTS PESTS
No. 183 Narcissus Flies (*Revised*)
No. 339 Chrysanthemum Eelworm (*New*)

Group IV. Birds

No. 237 The Carrion Crow (*Revised*)

Group V. Weeds

No. 190 Bracken Eradication (*Revised*)

Group VI. Other Publications

No. 236 Commercial Horticulture : Advice to Beginners (*Revised*)
No. 297 Sweet Corn (*Revised*)
No. 311 Sunflowers as a Seed Crop (*Revised*)
No. 343 Commercial Varieties of Apples and Pears (*Revised*)
No. 344 Migratory Beekeeping (*New*)

Animal Health Leaflets

No. 22 Worms in Poultry (*Revised*—superseding Advisory Leaflet No. 317)
No. 27 Swine Erysipelas (*Revised*—superseding Advisory Leaflet No. 17)
No. 30 Anthrax (*Revised*—superseding Advisory Leaflet No. 74)

Marketing Leaflets

No. 104 Recommended Grades for Pears (*New*) 2d. (3d. by post)

Other Publications

Smallholdings : First Report of the Smallholdings Advisory Council (*New*) 1s. 3d. (1s. 5d. by post)

Agriculture Overseas : Report No. 9—Green Crop Conservation in Germany (*New*) 1s. 0d. (1s. 2d. by post)

N.A.A.S. Quarterly Review No. 4 (*New*) 1s. 0d. (1s. 2d. by post). Annual subscription 4s. 6d. (including postage)

BOOK REVIEWS

Green Crop Dryers' Research Association Year Book, 1949. The Farmers Weekly. 10s. 6d.

Artificial drying is inherently the best—and indeed the near-perfect—method of conserving green forage ; but many difficulties have been encountered in the practical application of the process, and it would be wrong to suggest that all of these have been surmounted. Rapid progress is, however, now being made, and there is everything to be said for the publication of annual progress reports. This volume is the first of a projected series.

The book contains articles by recognized authorities on every aspect of the subject, excepting only its economics. Dr. Slade, in his introduction, apologises for the gap, explains that no sufficient body of cost data was available in time for the present issue, and promises that the want will be supplied in the next. There are informative advertisements of practically all the items of equipment that are at present available.

It is impossible to notice separately all of the twenty-five articles that the book includes. Some of these, like those by Dr. Holmes on the proteins and vitamins of grass, and by Mr. A. C. Hutt on fuels, are admirably clear explanations of basic scientific facts and principles. Others, by Prof. Stephen Watson, by Mr. Leonard Robinson and by Drs. Woodman and Evans deal with the use of dried grass in the nutrition of the different classes of livestock. Still others, by Mr. Gordon Saunders, Mr. William Alexander and Mr. T. S. Bennett, tell of personal and practical experiences. The exceptionally troublesome problem of drying sugar-beet tops is discussed shortly by Mr. Frank Rayns, and at length, on the basis of German experiences, by Dr. Kurt Seidel—the dilemma being that the fresh tops have an expensively high water ratio while the wilted material is often so heavily contaminated with soil as to give a dried product that is unsafe.

Dr. William Davies writes on the production of grass for drying, and Mr. J. L. Davies analyses the Milk Board's experience in the organization of communal drying.

A long article by Mr. Møller Nielson (incidentally not very well translated) shows that Denmark has encountered the same difficulties as ourselves in growing lucerne, and points to much the same precautions, aimed at reducing the risks of failure, that our own authorities recommend.

Mr. J. C. Lynn and Dr. A. B. Fowler speculate about the future ; the former, looking at the process with a business man's caution, should be read closely by the optimists ; the latter stresses the special difficulties in the co-operative organization of drying plants.

The Association is to be congratulated on producing a book that will be of great value to all who have a mind to set up in crop drying.

J.A.S.W.

The Potato. W. G. Burton. Chapman and Hall. 25s.

The avowed aim of this book is an attempt to summarize our knowledge of the potato vegetable as a source of food, more particularly from the viewpoint of a plant physiologist. And it is a very good attempt. The author seldom draws his own conclusions, perhaps wisely so, for much of the evidence cited is at times conflicting.

Much reading has gone into its preparation, as evidenced by the many references appended to each chapter. That indeed there are so many will surprise those unaware of the large amount of experimental work, mainly American, already done on the potato. They also show the need for properly co-ordinated work in this country. Most of the English references are to the few books published in this country on the potato, and to the experiments of the Rothamsted Experimental Station and of the National Institute of Agricultural Botany.

No attempt is made to deal with the cultivation of the crop, but the keen practical grower will find much of interest in the three hundred odd pages of the book, particularly in the chapter on the factors influencing yield, and on storage.

The student and young research worker will find this book most useful.

J.C.W.

Fuel and the Future. H.M. Stationery Office. 6s.

In agriculture large quantities of fuel are used in moving heavy or bulky materials and in raising temperatures to provide favourable conditions for plant growth or to destroy harmful organisms. *Fuel and the Future* is the report of a conference convened in 1946 by the Ministry of Fuel and Power, and in the section dealing with agriculture and horticulture the need for greater efficiency in use of fuel is stressed both by implication and by direct statement.

Nearly 1¼ million tons of solid fuel are used each year on the land, over one-half in heating glasshouses, but of greater importance is that this amount is used by a large number of relatively small-scale consumers, not all of whom are aware of the need for raising their standard of efficiency in fuel utilization.

This publication is well worthy of the attention of farmers and growers, for it not only indicates the need for greater efficiency and the direction in which that efficiency lies but also shows how it can be achieved. At the present time national advantage must have first place, but in fuel economy national considerations run hand in hand with the advantage to the individual consumer.

L.G.B.

The Production and Marketing of Pigs. H. R. DAVIDSON. Longmans, Green. 30s.

Now that the redevelopment of our pig husbandry back to or beyond its pre-war level is well under way, and perforce under conditions which differ widely from those prevalent before the war, it is clearly desirable that farmers, livestock advisers and agricultural students should have available for convenient reference the long-needed authoritative review of the present state of knowledge in the field of pig husbandry. All concerned are thus under a great debt of gratitude to Mr. Davidson for having undertaken, and successfully carried through, this formidable task. No specialist in pig husbandry could be better equipped, for he possesses the valuable combination of successful experience as teacher, research worker and practical pig breeder.

Throughout, what he stresses most, and rightly, is the necessity for regarding the results of pig management as the expression of a complex equilibrium conditioned by the simultaneous interaction of a large number of factors. Only thus can one avoid the distortion of interpretation that is so apt to arise from exclusive study of the effects of a single factor or group of factors, genetic, nutritional, environmental or otherwise.

The book has three main divisions. In Parts I and II, which take up about two-thirds of the volume, the author outlines the general principles involved in the sciences cognate to animal husbandry, with a shrewd analysis of the possibilities and limitations of their application in practice. The field covered by these sections is extremely wide, but particular mention should be made of Mr. Davidson's treatment of the problems of breeding and pig meat, to the elucidation of which his own work has made so great a contribution.

The level of treatment aimed at (especially in Part II) is that required for the institutional student at " pass degree " or " diploma " level, and the select minority of " study-minded " farmers. For the benefit of the " practical producer without scientific training," the essence of Mr. Davidson's philosophy and experience is distilled into Part III (Practical Aspects of Management), which for this class of reader is almost a text-book in itself.

This book fills a longstanding gap and is likely for many years to remain the standard British contribution to our reference literature on pig husbandry. It will make its strongest appeal to the classes of readers indicated above ; for the " average farmer " much of Part II will be difficult reading. Mr. Davidson can now confer a great boon if he will prepare a " farmers' digest " of his *magnum opus* for the pigman, who constitutes perhaps the most potent of the many factors that determine success in pig production.

C.C.

Journal of the British Grassland Society. Vol. 4, No. 2 (June, 1949).

The variety of grassland types, even in a small country such as Britain, produces problems particular to individual grassland and soil types. However, the combination of edaphic, climatic and environmental conditions is repeated in widely separated areas. A description by Laird of the grassland farming of the West of Scotland shows its resemblance to that of other areas within the country. It becomes increasingly clear, as a result of the expanded tillage acreage, that the sown sward is more and more relied upon to improve soil structure and control weeds, in addition to its primary function of providing herbage. With ensilage and artificial drying, the grass crop is entering the category of a concentrated food.

Wyllie Fenton has contributed a paper on " Vegetation Changes in Hill Grazings with Particular Reference to Heather". The heather moor forms one of the most distinctive and valuable grazing associations on hill land. The management of the heather moor, largely by burning, is outlined, but it would appear that the operation is by no means simple and that it needs careful adjustment to the age and condition of the growth if vigorous heather is to be maintained ; further experiments and research are required.

Raymond *et al.* report on the progress made in the use of cold storage at *c.* 0° F. to increase accuracy in determining the digestibility of fresh herbage.

A contribution by Champness deals with the variability encountered in sampling fields for the determination of viable seed in the soil.

Some new research projects undertaken in overseas countries are described briefly in notes contributed by the Commonwealth Bureau of Pasture and Field Crops. These include land use and rotation experiments being conducted in South Africa, aerial distribution of seed and fertilizers in New Zealand, and recent trends in Soviet Grassland Research.

Semple, in a paper entitled " Some Grass Species of Ethiopia," gives an account of some typical grass associations and species encountered while the author was in that country as an officer of F.A.O.

T.E.W.

BOOK REVIEWS

Mammals in Britain. MICHAEL BLACKMORE. Collins. 15s.

For an attractively presented and clearly expressed introduction to the study of British mammals, Mr. Blackmore's book may be highly recommended. It fulfils what I imagine is the author's purpose in whetting the appetite for more; and for that reason I wish he had included a selected bibliography for further reading.

Compared with our bird life, the number of British mammals is few; yet, for all that, they have attracted less field study. In these circumstances, therefore, it is not unnatural that superstition, as absurd as it is unjust, has grown up around them, and in some parts of the country has hardened into a prejudice which it is difficult to eradicate.

This book is particularly welcome, therefore, in setting out quite simply the facts of the life histories and habits of such common British mammals as the moles, shrews, hedgehogs, rabbits, hares, rodents, foxes, badgers, otters, deer, and bats. The chapter on bats is, indeed, quite the best in the book.

As Mr. Blackmore points out, the bat is not the half-bird, half-mouse creature popularly suggested by the name of "flittermouse" attached to it in some rural areas. It is a true mammal of some fifty to sixty million years' ancestry, and the only one capable of real flight, living entirely upon insect life. Bats are wholly beneficial to man and should not therefore be molested.

Not so, for example, the vole, when its numbers increase unduly. Mr. Blackmore records that in the vole plague years of 1891–93 in southern Scotland, thousands of acres of grass "were eaten down to the roots, so that the land became quite bare and lambs actually died of starvation". Fortunately, however, such occurrences are rare.

The value of the text is enhanced by many first-class half-tone reproductions, which reflect the infinity of patience required by the naturalist photographer who is determined to get his picture.

S.R.O'H.

Birds in Britain. FRANCES PITT. Macmillan. 25s.

The best reason for writing a book is that you wanted to write it, and this is the reason Frances Pitt has given for adding yet another to the legion of bird books. She has given another reason too—that she felt there was still room for something between Coward's book for beginners in ornithology and Witherby's *Practical Handbook* for experts.

Birds in Britain (which is in the same fine series as *Flowers in Britain*, *Trees in Britain* and *Dogs in Britain*) offers a survey of bird life (domestic as well as wild, but primarily wild) in Britain. Introductory sections deal with the bird's place in the natural economy, the physical structure of birds (with special emphasis on the functional aspect of that specialized structure), the migration problem, and general questions of bird behaviour. On the last two subjects the author has managed to steer a refreshingly sane middle course between the extremes of cold science and emotional anthropomorphism.

The main body of the book is devoted to detailed descriptions of the birds: their plumage and general appearance, habits, breeding characteristics, and so on. It would be presumptuous of me to remark that Frances Pitt knows what she is talking about—her name has been a household word since before the days when I was first meeting the robin in a picture book at my father's knee—but I may perhaps add that there is not one page among the six-hundred in this fine book where the author's inimitable personal touch does not enrich with personal experience and observation the facts which she presents so adequately.

Winifred Austen has designed a lovely pictorial jacket of goldfinches on cornflowers and there are sixteen admirable coloured plates by Roland Green. For the rest, illustration is by photographs, and their complete adequacy confirms a growing conviction of mine that colour is a secondary aid to identification; poise, stance, manner—what the wildfowler generically calls "jizz"—these are what give each bird its unmistakable label, and they are caught more often and more infallibly by the camera than by the most careful draughtsman-artist.

It is a rich book in every sense of the word, recommended alike to the beginner who wants to begin correctly yet needs a little human help, and to the expert who appreciates an element of personal observation added to his facts. But most of all, perhaps, a book for the "half-and-halfer" (like myself) who knows a hawk from a hand-saw but still has a long way to go.

E.M.B.

BOOK REVIEWS

Geology and Scenery in England and Wales. TRUEMAN, A. E. Pelican Books. 2s. 6d.

When the farmer and the agricultural adviser lift their eyes from the crops and the luscious leys of England and Wales, they see that scenery which has made this country famous and the object of nostalgia of many an exiled Briton in less favoured environments. " Its mountains are not high, nor its rivers long, but within a few hundred miles of travel from East to West an Englishman may see more varieties of scenery than are to be found in many bigger countries." It is in order to help one to appreciate the background of landscape that Professor Trueman has produced this most readable book on what might at first glance appear to be a somewhat dry subject.

This Pelican is a reprint with only minor modifications of an edition which appeared in 1937.

The relationship is traced between the geological structure and rock types, and the landscape features such as forms of hills and the course and nature of valleys, and so on to the types of villages which have been built of local stone, and which have thus become such characteristic features of the various regions of the country.

Starting with the Cotswold Stone Belt and its northern extension into Northamptonshire, Leicestershire, Lincolnshire and Yorkshire, Professor Trueman then turns to the chalk areas of England, " which Huxley thought so suggestive of mutton and pleasantness, . . . wide expanses of grassy downland and the smooth rounded curves of the hills. . . . On these rolling hills clumps of beech crown many summits, but great areas are given up to sheep pastures, and there are wide stretches of open tillage. Farms are few, and often are so placed in the valleys that in a view over miles of country scarcely any are in sight."

The theme is continued in an equally interesting way through the heart of England, the London basin, the Weald of Kent and Sussex, the South coast, East Anglia, the Fenlands, mountain limestone, Pennine moorlands, the Lake District, and so into Wales, which is divided into North, Central, South, and the Borderland. The book ends in the South-west, in the Bristol district and the Somerset Plain, Exmoor and the North Devon coast, South Devon and Cornwall.

This book will certainly heighten the interest and appreciation in that " scenery " which the average Briton tends to take rather for granted, and should certainly become a *vade mecum* for the overseas visitor whose interests and wanderings lead him into the English and Welsh countryside.

R.O.W.

William Cobbett. W. BARING PEMBERTON. Penguin Books. 1s. 6d.

It is more than a century since William Cobbett died, yet few men of his time (a great and memorable period in English history) are so frequently quoted as he. What was there about Cobbett that has marked him off as one of our greatest Englishmen ? In a sense he was a failure, notwithstanding his many achievements ; he was given to faulty judgment and in many ways he was remarkably contentious and intolerant. But he bore no malice; he was fair-minded, a clean fighter and intensely human ; above all, he was never vulgar. He farmed but he was not a great farmer, despite his keen interest in experiments ; he wrote but he was not a great writer, although his *Rural Rides* has become, and will remain, a classic of our literature. The real answer, probably, is that Cobbett makes us *feel* the England of his day and thereby he belongs to that small but very select company wherein are found Pepys, Evelyn, Bunyan, Borrow, Latimer, Walton, White, and Fielding.

Cobbett's seventy-two years of active life, into which he crowded so many interests, present a fertile field for the biographer. In such a field the politician, the economist, the philosopher, and even the wit have alike delved profitably, though perhaps somewhat partially. It was inevitable, however, that this vivid and picturesque figure of English social history would some day come under a biographical examination by a competent historian. Thus it is gratifying to welcome a new and specially written Cobbett life to the list of Penquin biographies. Few more competent to accept the task of writing such a book than Mr. Pemberton could have been found. He has given us an intensely interesting and critical account of Cobbett's whole life in which no words are wasted and yet nothing of importance is omitted. The author rightly emphasizes that Cobbett's greatness belongs to the last fifteen years of his life. In 1820 he was fifty-eight, his fortunes were at a low ebb (he was in debt and had lost the Botley property), but finding himself free from the day-to-day cares of his farming interests, and having settled at Kensington, he was free to plan his rides east, west, north and south to explore the countryside he loved so well. We see him as Mary Mitford described him : " . . . a tall, stout man ; fair and sunburnt, with a bright smile, and an air compounded of the soldier and farmer, to which his habit of wearing a red waistcoat contributed not a

little". We have a mental picture of him, all through those eight years after 1821, carrying out that painstaking examination of rural England, surveying the soils, criticizing the crops and noting the condition of the people, no mean task for a man past sixty years of age. And in writing of his experiences he found just the right language, so that *Rural Rides* stands out clearly, by itself, as a piece of descriptive writing about rural life which placed Cobbett immortally beside Cato.

Mr. Pemberton skilfully examines this closing period of Cobbett's life, which included a few years as member of Parliament for Oldham. And although it is more than a century since this remarkable Englishman " leant quietly back in his chair, as if to sleep, and was at peace with the world," his voice speaks to us of this generation, bringing a message.

In the minds of Englishmen the name of Cobbett stands as a symbol of unswerving purpose and constancy of character. Constancy was the golden thread running through all the years of his life, and in the words of Coriolanus, he could have proclaimed : " while I remain above the ground you shall hear from me still; and never of me ought but what is like me formerly".

A.H.H.

Britain Can Breed It. FARMER AND STOCK-BREEDER. 12s. 6d.

Farmers and stockbreeders are notoriously prone to hide their light under a bushel, but the days when a good article needed no advertising have gone—even if they ever existed.

Mankind the world over has benefited from the results of the skill of British stockbreeders, and immense businesses have been set up to deal with the products of meat, bones, hides, milk, and wool. So satisfactory were the animals which were exported that buyers of British stock returned again and again to obtain replenishment for their herds and flocks. This demand is still far from being satisfied, although there are now other competitors in the livestock field who in turn have also largely built their foundations on stock of British origin.

The book deals with British breeds of horses, cattle, sheep and pigs, giving a short history of their origin, qualities, capabilities and uses. In addition the illustrations speak for themselves and clearly show the excellence which British livestock has attained.

The publication will be most helpful to foreign buyers when selecting the breed or type required, and it should do much to assist in earning the dollars which Britain needs so badly. It is also of no less interest to British stockbreeders, who can see breeds which are seldom seen together except at national shows. The publication is, in fact, a national show in itself, with the added advantage of information on use.

Both authors and publishers are to be congratulated on producing a publication which, with its excellent illustrations, will be of great value to foreign and British breeders.

H.T.

Landmarks. A. G. STREET. (Illus. by Denys Watkins-Pitchford). Eyre and Spottiswoode. 12s. 6d.

Mr. Street has reached the age when he feels that he can look back over his shoulder without apology. The result is *Landmarks*, a pleasing collection of reminiscences of Wiltshire rural life. Much of the old familiar scene is changed : the dwindling number of hayricks against the downland skyline as more and more hay is baled into neat oblong packs ; fewer lines of stooked corn set in aisles upon short stubble as the combine harvester ousts reaper and binder ; the mechanic's bench and the smell of oil where once there was harness and the scent of saddle soap and leather ; the old willow, the friend of generations of children, lovers and old men, a casualty to planning. These and many other landmarks, the remembered things of youth, emphasize the passing of the years and the coming of new ways, new ideas. That is not to say, however, that Mr. Street's writing is a lament for the old order, for where progress in farming is concerned we shall always expect to find him to the fore. But there is in every man a streak of inconsistency which, whilst admitting the inevitability, and often the desirability, of change, yet acknowledges the loss of an old " landmark " with a sigh.

For the most part Mr. Street the farmer is off duty in this book. With all the self-conscious pleasure of a schoolboy playing truant, he hunts, fishes and shoots; he attends the village flower show, the cricket match, the local gymkhana ; he approves the blue smoke of a hedger's fire spiralling to a winter sky, a line of cool limes beside the lake, a pattern of cloud riding the downland fields. Though some landmarks are lost, others, such as those which Thomas Hardy had in mind, " will go onwards the same, though dynasties pass".

S.R.O'H.

BOOKS RECEIVED

The Grazing Animal. J. F. H. THOMAS. Faber. 15s.

Marketing Poultry Products. (4th Edition). EARL W. BENJAMIN, HOWARD C. PIERCE and W. D. TERMOHLEN. Chapman and Hall. 36s.

Introduction to Agricultural Economics. EDGAR THOMAS. Thomas Nelson. 10s. 6d.

Cation Exchange in Soils. W. P. KELLEY. Chapman and Hall. 27s.

The Plums of England. H. V. TAYLOR. Crosby Lockwood. 30s.

A Full Life in the Country. KEITH JEREMIAH. Batsford. 12s. 6d.

Life in an English Village. Sixteen Lithographs by Edward Bawden with an Introductory Essay by Noel Carrington. Penguin. 1s. 6d.

British Herbs. FLORENCE RANSON. Penguin. 1s. 6d.

The Flower and the Wheel. ADRIAN BELL. Bodley Head. 7s. 6d.

The Food Manufacturing Industry in Germany during the period 1939-1945. (British Intelligence Objectives Sub-Committee Overall Report, No. 14). H.M.S.O. 2s. 6d.

The Potentialities of Wind Power for Electricity Generation (with special reference to Small-Scale Operation). E. W. GOLDING and A. H. STODHART. The British Electrical and Allied Industries Research Association (Technical Report Reference W/T 16). 1s. 6d.

Machinery on the Farm. THOMAS HUTCHISON. Blackie. 17s. 6d.

Woodland Crafts in Britain. H. L. EDLIN. Batsford. 15s.

Soil Fertility and Sewage. J. P. J. VAN VUREN. Faber. 18s.

The English Rural Labourer. G. E. FUSSELL. Batchworth. 12s. 6d.

Catalogue of Books on Agriculture, Horticulture, Animal Husbandry and Veterinary Science (1949). H. K. Lewis.

"AGRICULTURE"

Price 6d. net monthly, post free. (Foreign countries, 8d. post free).

Subscription Rates (including postage):

Inland and Imperial	.. ..	6s. per annum
Foreign Countries	.. ..	8s. per annum

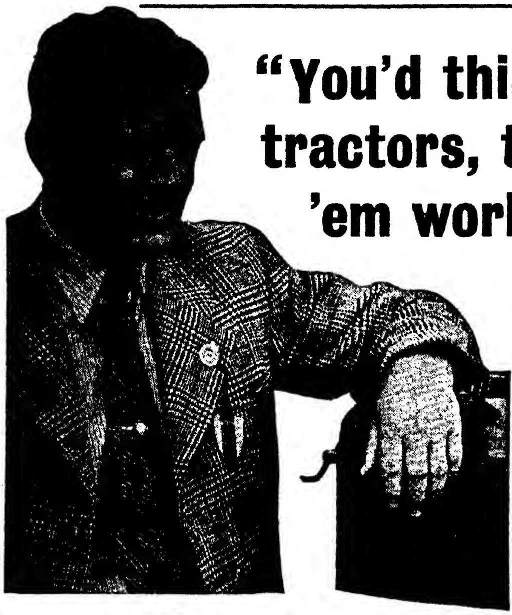
Subscription may start with any issue and should be sent to

H.M. STATIONERY OFFICE,
York House, Kingsway, London, W.C.2; 13a Castle Street, Edinburgh 2
39 King Street, Manchester 2; 2 Edmund Street, Birmingham 3
1 St. Andrew's Crescent, Cardiff; Tower Lane, Bristol 1;
80 Chichester Street, Belfast.

Single copies can be purchased from any of the above-mentioned addresses or through a bookseller.

Printed in Great Britain under the authority of HIS MAJESTY'S STATIONERY OFFICE by C. Nicholls & Company Ltd., The Philips Park Press, Manchester, London and Reading

FARMERS' FORUM No. 3



"You'd think I hated tractors, the way I make 'em work!"

SAYS MR. PHILIP HALL, ENTERPRISING YOUNG POWER-FARMER OF CREDENHILL, HEREFORD.

"—Engine-power is there to be used. I use it from dawn till dusk, on every possible kind of job — as a result I get through more and more work in far less time."

Mr. Hall plans each tractor's day down to the last five minutes. Besides field work, he uses power for every possible haulage and transport job. And success is proving him right. Down at Credenhill he grows wheat, barley, oats, hops, root crops, and fruit; he raises fine Hereford cattle, sheep and pigs, and also does a specialist line in Rhodes, Sussex and Leghorn fowls.

A great believer in pneumatic tyres, Mr. Hall has nearly all his tractors and implements mounted on Goodyear. Here's the way he argues: Speed is money to the power-farmer, and Goodyear tyres keep farm work steadily on the go in practically all weathers. They greatly increase turnover, economise in fuel and labour costs, and protect implements from "Clatter-batter wear and tear", as Mr. Hall picturesquely puts it. In addition, Goodyear tyres outlast all others.

" You can quote me as a Goodyear enthusiast," says Mr. Hall.

GOODYEAR build tyres for every farming job—to help you get through the work quicker, without the "judder" that ruins good implements.

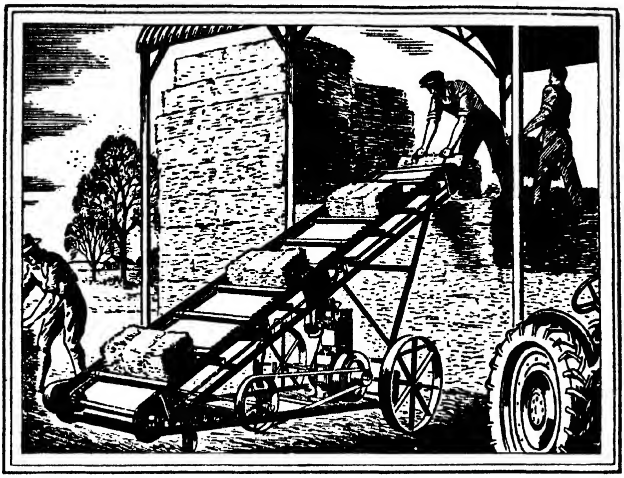
In particular, the Goodyear Sure-Grip Tractor Tyre with its famous o-p-e-n c-e-n-t-r-e tread gets your tractors through more work in less time than you ever thought possible. Look at those mighty lug-bars! See the bite-points? . . . They dig deep into the ground, followed by the whole length and breadth of the lug-bars. Four-at-a-time those rugged self-cleaning Goodyear bars drive the tractor forward, extracting the uttermost ounce of power from your engine by sheer, down-to-earth *wheel-adhesion.*

Speed the plough with

GOODYEAR

SURE-GRIP TRACTOR TYRES

and grow more food for Britain



There's no better engine than a PETTER

Farmers have known this for sixty years. Today it is truer than ever. New plant and up-to-the-minute production methods have enabled Petters to reduce prices while improving precision and quality. By buying a Petter you save money, and get an engine backed by a fine reputation and first class dealer-service. There is a model to suit every job on the farm: petrol 1½ to 10 b.h.p. or diesel 3 to 10 b.h.p. Delivery four weeks from date of order. Ask your local A.M.T.D.A. dealer for full information, or write to:—

Petter

ASSOCIATED BRITISH OIL ENGINES LIMITED CAUSEWAY WORKS, STAINES, MIDDLESEX. TELEPHONE STAINES 1122
(PETTER SMALL ENGINE DIVISION)

A15

PESTOX III and RED SPIDER

Pestox III the new systemic insecticide has already proved successful in controlling hop aphis.

Recent experiments in Red Spider Control have also given successful results, fuller details of which will be announced later.

PEST CONTROL (U.K.) LTD

CAMBRIDGE   Telephone: Harston 312/6

Agriculture

The Journal of the Ministry of Agriculture

PUBLISHED 6d MONTHLY

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

Editorial Offices: St. Andrew's Place, Regent's Park, N.W.1 (*Phone : WELbeck 7711*)

VOL. LVI No. 7 OCTOBER 1949

Contents

Cover Photograph

GRASSLAND INTO ARABLE AT EAST DUNDRY, SOMERSET .. .. *REECE WINSTONE*

YOU *NEVER* PAINT THE ALUMINEX

WORK OUT IN ROUND FIGURES THE SAVINGS ON THIS ITEM ALONE			
ITEMS	OLD HOUSE	ALUMINEX	ALUMINEX SAVING
INITIAL PAINTING			
(a) Cost of materials . .		NIL	
(b) Cost of labour . .		NIL	
AVERAGE YEARLY PAINTING			
(a) Materials		NIL	
(b) Labour		NIL	
Average Yearly Renovations to frame due to rust and rot		NIL	
TOTAL SAVING			
GROWERS' UPKEEP COSTS ENORMOUSLY REDUCED			

This is one of the 20 MAJOR IMPROVEMENTS in the Aluminex greenhouse

You never paint the Aluminex greenhouse because it is made of aluminium alloys which never corrode, never rust. Instead, weathering produces a hard permanent patina on the surface of the metal which protects it all its long life.

Thus, immediately, you are able to strike out one of the biggest items on your upkeep bill—painting. That is not all. The 20 major improvements in greenhouse design which have been incorporated in the Aluminex save you money in 12 ways. Upkeep expenses which cost growers more than 5 per cent of the purchase price of their houses every year, are slashed to negligible proportions.

Why the Aluminex gives flourishing crops and cuts upkeep costs

1 *Ventilators run whole length of house on continuous hinges, giving even flow of air throughout, and healthy conditions.*

2 *Airtight construction and accurately adjustable ventilation get the best out of the heating system and save fuel.*

3 *24" Standard panes and slimmed metal frame admit maximum daylight.*

4 *No pests harboured on the smooth metal surfaces.*

5 *Puttyless glazing cuts out periodical re-puttying and makes replacement of broken panes a simple, economical, two-minute job.*

6 *Ample room for cultivators to enter and manoeuvre inside.*

7 *Aluminex aluminium frame is strong and will last several lifetimes of the ordinary timber house.*

8 *Wide stout guttering gives easy access for roof work.*

These—and more—advantages of the Aluminex are explained in detail in the illustrated brochure sent to you on request.

The ALUMINEX

is the grower's big profit-making investment

Write today to: **ALUMINEX GREENHOUSES LTD. (Dept. AG.2), 19 KING STREET, TRURO**

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LVI No. 7 OCTOBER 1949

THE NEW MILK REGULATIONS

THREE new Regulations, made under the Food and Drugs (Milk and Dairies) Act, 1944, which come into operation on October 1, 1949, will affect the whole of the dairying industry in England and Wales, from the producer-retailer to the large commercial liquid milk producer and distributor. They are:

1. Milk and Dairies Regulations, 1949 (made jointly by the Ministers of Health, Agriculture and Food);

2. Milk (Special Designation) (Raw Milk) Regulations, 1949 (made jointly by the Ministers of Health, Agriculture and Food);

3. Milk (Special Designation) (Pasteurised and Sterilised Milk) Regulations, 1949 (made jointly by the Ministers of Health and Food).

These Regulations re-enact, with amendments to bring them into line with present-day dairying practice, the provisions of the Milk and Dairies Regulations, 1926-43, and the Milk (Special Designations) Regulations, 1936-48.

The Milk and Dairies Regulations, 1949 One of the recommendations in the Government White Paper *Measures to Improve the Quality of the Nation's Milk Supply* (Command Paper No. 6454), issued in 1943, was that the Minister of Agriculture and Fisheries should take over from local authorities their responsibilities relating to the conditions under which milk, including designated milk, is produced on the farm. Under the new Regulations, the registration of dairy farms and dairy farmers and the control of conditions under which milk is produced on farms now becomes the responsibility of the Minister of Agriculture and Fisheries. Local authorities, however, retain their previous responsibilities in regard to distributors of milk (other than producer-retailers in so far as they distribute their milk direct from the farm where it is produced). Local authorities will also, through their Medical Officers of Health, be responsible for administering precautionary measures for preventing milk becoming infected, whether on the farm or not, with disease communicable to man.

It is an offence under the Regulations for anyone to carry on the trade of dairy farmer or to use any premises as a dairy farm unless he or the premises are registered. But all those persons trading as dairy farmers and those premises used as dairy farms immediately before October 1, 1949, will be deemed to have been registered and will be notified to that effect by the Minister. Anyone who does not receive a notification may apply for registration.

The Minister of Agriculture and Fisheries may refuse the registration of a dairy farm or dairy farmer if he is satisfied that the Regulations cannot be complied with, and may cancel a registration if the Regulations are not being complied with. Before the registration of a dairy farmer or dairy farm is refused or cancelled, however, the dairy farmer may lodge an objection, in which event the Minister must refer it to a tribunal consisting of three members: an independent chairman, one person from a panel nominated jointly by the National Farmers' Union and the Milk Marketing Board, and a person representing the consumers' interest. The tribunal's duty is to determine the facts of the case, and the Minister must consider their report in reaching his decision. In addition to being heard by a tribunal, a dairy farmer may make representations to the Minister of Agriculture and Fisheries that the registration should not be refused or cancelled.

The Regulations lay down conditions with regard to the use, construction, and maintenance of buildings used in connection with the production, handling, storage, and processing of milk. Not all buildings on dairy farms comply fully with these conditions at present, and the Regulations permit the Minister of Agriculture and Fisheries to use his discretion as to their continued use, but only for so long as he considers desirable. A point of interest is that the "dry cowshed" and the "milking bail" will be allowed in suitable circumstances.

Satisfactory methods of production, handling, processing and storage of milk are vital, and the Regulations prescribe methods which must be followed. As a general rule milk must be cooled by the producer to a temperature not exceeding 50°F. or to within a temperature of 5°F. of the water supply available for cooling. Milk must also be cooled once in the chain of distribution to a temperature not exceeding 50°F. In certain circumstances, however, distributors are allowed, for a period of five years, to cool milk to within 5°F. of the water supply available for cooling.

Responsibility for the enforcement of the provisions of the Regulations dealing with the protection of milk from infection rests with local authorities through their Medical Officers of Health. Milk can be diverted for heat treatment if the Medical Officer of Health suspects that the milk is infected or has caused infection; and the supply can be stopped or diverted for heat treatment if he has satisfactory evidence that the milk is infected or has caused infection. Compensation is payable in certain circumstances for milk so stopped or diverted.

The Regulations also make provision for the protection of milk against contamination, the cleansing and storage of vessels, utensils and appliances, and the conveyance and distribution of milk. Cleansing of utensils or appliances with an approved chemical agent, as an alternative to scalding with boiling water or steam, is permitted.*

Finally, the Regulations require that a Central Milk and Dairies Advisory Committee and a similar Committee in each administrative county shall be appointed to keep under review the operation and administration of Milk and Dairies Regulations and all Milk (Special Designation) Regulations. The County Committees will report and can make recommendations to the Central Committee, which in its turn will report to the Minister of Agriculture and Fisheries. The Central Committee will include amongst its members representatives of producers and distributors of milk (including the co-operative milk trade), veterinary surgeons, landowners, County

*** A special article on the use of approved hypochlorites in milk production is on pp. 304-9 of this issue.**

Councils and other local authorities. Before setting up a County Advisory Committee the Minister of Agriculture must consult the County Council, the other local authorities, the County Agricultural Executive Committee, distributors of milk (including any co-operative milk traders), veterinary surgeons, and landowners.

The Milk (Special Designation) (Raw Milk) Regulations, 1949 These Regulations deal only with the special designations that may be used in relation to the sale of raw milk. [N.B. The designations which may be used in relation to heat-treated milk are dealt with in the Milk (Special Designation) (Pasteurised and Sterilised Milk) Regulations, 1949, made by the Ministers of Health and Food.] The special designations for raw milk are "Tuberculin Tested" and "Accredited". The power to grant licences to milk producers (including producer-retailers so far as milk produced by them is concerned) to use these designations will now rest with the Minister of Agriculture and Fisheries. Dealers' licences will continue to be granted by local authorities.

The use of the special designation "Accredited" will not be permitted after October 1, 1954. [N.B. This is subject to the qualification that under the Milk (Special Designations) Act, 1949, the use of the designation "Accredited" in a specified area is prohibited unless all the milk is from a single herd.]

No further licences to use the designation "Accredited," whether new licences or renewals of existing licences, will be granted after September 30, 1952.

Producers' licences to use the special designation "Tuberculin Tested" taken over by the Minister of Agriculture and Fisheries on October 1, 1949, from County and County Borough Councils will be valid for five years. Producers' licences granted in respect of an application made between October 1, 1949, and September 30, 1951, in relation to milk from a non-attested herd will be valid for five years only, unless the herd becomes attested. Producers granted licences in respect of applications made after September 30, 1951, and before October 1, 1954, in relation to milk from a non-attested herd will be allowed a licence for three years only, unless the herd becomes attested. No licences to use the special designation "Tuberculin Tested" will be granted to producers applying after September 30, 1954, unless the herd in respect of which the licence is applied for is attested.

No licences to use the designation "Tuberculin Tested" in relation to milk from a non-attested herd will be valid after September 30, 1957.

The Regulations make provision for the consideration of appeals against a decision to refuse, suspend or revoke a producer's or dealer's licence to use a special designation. Special conditions apply where the licence is held by a retailer for an area specified under the Milk (Special Designations) Act, 1949, in which event the appeal is to be referred to a tribunal.

Details of the conditions subject to which licences are to be granted (including, in particular, conditions as to the health of the cattle and precautions to be taken against infection of cattle, the handling and bottling of the milk and the requirement that the milk shall pass a test), the method of sampling and testing milk, and the constitution and procedure of tribunals are prescribed in the schedules.

The Milk (Special Designation) (Pasteurised and Sterilised Milk) Regulations, 1949 These regulations authorize the use of the special designations "Pasteurised" milk and "Sterilised" milk and, where the appropriate licences are held, the special designations "Tuberculin Tested Milk (Pasteurised" and "Tuberculin Tested Milk (Sterilised)".

The present "holder" and "high-temperature short-time" methods of pasteurizing are re-stated, and provision is made for the recognition of any other method which the Minister of Food may approve. The method for the sterilization of milk is specified.

From October 1, 1950, pasteurized milk will be sold only in bottles or other containers, and, from October 1, 1954, the bottles or other containers must be filled at the pasteurizing premises.

Licences The licensing arrangements under the Raw Milk and the Pasteurised and Sterilised Milk Regulations will be as follows:

1. Producers' licences for raw milk will be granted by the Minister of Agriculture and Fisheries;
2. Dealers' licences for pasteurizing and sterilizing establishments will be granted by Food and Drugs Authorities;
3. Local authorities will continue to be responsible for all other licences, except dealers' licences issued to a local authority or County Council by the Minister of Food; and
4. No payment will be required for licences.

STERILIZATION OF MILK UTENSILS BY SODIUM HYPOCHLORITE ON SMALL FARMS PRACTISING HAND MILKING

A. ROWLANDS, B.Sc.

National Institute for Research in Dairying, Shinfield, Reading.

TREATMENT with steam is undoubtedly the most reliable, and generally the most convenient, method of killing bacteria on utensils used in milk production. It is not, however, the only method. In some circumstances sodium hypochlorite preparations approved by the Ministry offer an attractive alternative to steam.

The results of the trials described below show that for the treatment of the few utensils used where small herds are hand milked hypochlorite is satisfactory, provided it is properly applied. This conclusion is based on the keeping quality of the milk produced, and is without reference to the relative cost of steam and hypochlorite sterilization.

The trials also included a comparison of the keeping quality of milk from farms where the milk was cooled by standing the churns in a trough of water with that from farms using a surface cooler. The water used for cooling by both methods was that available on the farms and was not refrigerated by mechanical means.

Plan of Trials These trials to test the value of hypochlorite sterilization of milk equipment on farms milking up to 12 cows by hand were carried out in *ten* areas of England and Wales during July-September, 1946, and in *six* areas during the same period of 1947. During 1946 there were three groups :

GROUP A. Farms supplied with new utensils, troughs, and brushes for washing the equipment, and troughs in which to immerse the churns in water for cooling.

GROUP B. Farms using their existing utensils and facilities for washing the utensils and cooling the milk.

GROUP C. Farms included as controls and not informed that they were included in the trials.

Group A and B farms sterilized their utensils with hypochlorite, whereas the methods remained unchanged on Group C farms. Other methods practised on all farms, except in so far as Group A farms adopted immersion cooling, remained unchanged.

During the summer of 1947 the trials were extended to include two additional groups, D and E ; 5 of the 6 areas included Group D farms, and 3 of the 6 areas Group E farms.

Group D. Control farms corresponding to Group C, except that the farmers were informed that they were included in the trials.

GROUP E. Farms using steam for sterilizing the equipment.

The number of farms included in each group during the two summers is shown in Table 1.

Table 1

Number of Farms in each Group

Group	1946	1947
A	47	30
B	49	30
C	48	30
D	—	25
E	—	15

To encourage regular application by the farmers, the treatment of the utensils was designed to be as convenient and as simple as possible, consistent with efficiency of sterilization. Farmers in Groups A and B received instruction in the use of hypochlorite at the beginning of the trials in 1946, and a printed card giving, very briefly, the methods to be followed was left at each farm. A copy of the card is reproduced below.

Treatment of Utensils after MORNING Milking

(a) *Immediately after milking* rinse all utensils in cold water : use a brush to remove outside dirt.

(b) Immerse and scrub in *chlorine-soda wash*.

(c) Rinse in *chlorine-water* and invert on a clean rack to drain.

Treatment of Utensils after EVENING Milking

(a) *Immediately after milking* rinse all utensils in cold water : use a brush to remove outside dirt.

(b) Immerse and scrub in *chlorine-rinse* and invert on a clean rack to drain.

Preparation of Solutions

1. *Chlorine-soda wash* (*c.* 250 p.p.m. available chlorine). In 10 gallons of warm water dissolve 4 ounces of soda ash (or 8 ounces of washing soda) and add 4 fluid ounces of approved stock sodium hypochlorite solution.
2. *Chlorine-water* (*c.* 10 p.p.m. available chlorine). To 10 gallons of water add 3 pints of the freshly made *chlorine-soda wash.*
3. *Chlorine-rinse* (*c.* 60 p.p.m. available chlorine) for use after the evening milking. To 10 gallons of water add 1 fluid ounce of approved stock sodium hypochlorite solution.

All farms in Groups A and B were supplied with approved hypochlorite solution and soda ash.

Results The results for 1946 and 1947 are summarized in Tables 2, 3 and 4. Since the 15 farms in Group E during 1947 were in only three of the six areas, the results obtained by the 15 farms in each of the Groups A, B, C and D in the same three areas are given in brackets in the Tables: these bracketed figures should be used in comparing the results for Group E farms with those obtained by farms in other groups. In addition to combined results for all Group B farms, figures are given separately for farms in this group using surface or immersion cooling: 18 and 20, respectively, in 1946, and 11 and 14 in 1947.

REJECTION TEST RESULTS. Some creameries have adopted the practice of returning to farms milk with a disc reading of 3½ or less by the 10-minute resazurin test at the time of arrival at the creamery. The percentage of churns failing by this test is shown in Table 2.

Table 2

Number of Churns tested and Percentage failing by the 10-minute Resazurin Test

Farm Group	1946				1947			
	Morning Milk		Evening Milk		Morning Milk		Evening Milk	
	No. Tested	Per cent	No. Tested	Per cent	No. Tested	Per cent	No. Tested	Per cent
A	2,291	0.6	2,361	3.0	1,018	0.5 (0.4)	1,407	7.6 (10.8)
B*	2,529	1.8	2,833	5.2	1,211	1.5 (2.3)	1,285	8.2 (13.1)
C	2,537	1.8	2,719	8.7	960	1.8 (2.2)	1,364	10.0 (12.4)
D	—	—	—	—	1,260	1.9 (2.6)	1,724	12.4 (21.3)
E	—	—	—	—	733	0.3	779	6.4
*B Immersion cooling	1,173	0.9	1,398	1.7	607	1.8	716	14.4
B Surface cooling	1,061	1.7	1,151	5.6	604	1.2	569	2.3

KEEPING QUALITY RESULTS. The samples were placed in a water bath at 64°F. (18°C.) at 4 p.m. on the day of delivery to the creamery. Samples which clotted when boiled at 9 a.m. the following morning were classed as unsatisfactory. The percentage of samples failing this keeping quality test —1 day for morning milk and 1½ days for evening milk—is shown in Table 3.

Table 3

Number of Samples tested and Percentage with an Unsatisfactory Keeping Quality

Farm Group	1946 Morning Milk No. Tested	1946 Morning Milk Per cent	1946 Evening Milk No. Tested	1946 Evening Milk Per cent	1947 Morning Milk No. Tested	1947 Morning Milk Per cent	1947 Evening Milk No. Tested	1947 Evening Milk Per cent
A	488	2.9	576	16.8	199	14.6 (16.0)	339	33.2 (38.2)
B*	562	2.5	652	22.3	255	11.8 (15.3)	292	42.8 (47.5)
C	515	6.2	626	33.4	219	24.6 (26.9)	338	47.7 (51.3)
D	—	—	—	—	217	16.5 (20.0)	305	41.0 (49.8)
E	—	—	—	—	146	11.0	178	34.2
*B Immersion cooling	215	1.9	236	19.5	137	15.3	171	56.2
B Surface cooling	243	2.5	313	20.1	118	7.6	121	24.0

Thermoduric Bacteria. These bacteria are not killed when milk is pasteurized at 145°F. for 30 minutes, and they are of importance, therefore, in milk used for processing. Since they are added to milk mainly from utensil surfaces, the number in milk is an index of the efficiency of cleaning and sterilization of utensils. The percentage of samples containing more than 10,000 of these bacteria per ml. of milk is shown in Table 4.

Table 4

Number of Samples tested and Percentage containing more than 10,000 Thermoduric Bacteria per ml.

Farm Group	1946 Morning Milk No. Tested	1946 Morning Milk Per cent	1946 Evening Milk No. Tested	1946 Evening Milk Per cent	1947 Morning Milk No. Tested	1947 Morning Milk Per cent	1947 Evening Milk No. Tested	1947 Evening Milk Per cent
A	483	12.2	573	10.5	157	10.0 (7.8)	283	17.2 (20.4)
B*	560	13.3	647	13.0	194	20.1 (26.2)	266	29.7 (36.6)
C	514	29.2	626	39.9	170	31.3 (22.8)	288	52.4 (50.1)
D	—	—	—	—	218	25.8 (28.7)	305	47.9 (49.0)
E	—	—	—	—	146	5.5	176	17.2
*B Immersion cooling	232	11.2	296	13.2	83	18.1	115	32.2
B Surface cooling	237	16.4	260	14.9	111	21.6	120	23.7

How the Weather affected Results From a study of the Tables it is immediately apparent that during 1947 there was a marked increase in the incidence of unsatisfactory samples, as compared with 1946. During 1946 the production of milk of satisfactory quality was favoured by the prevailing low temperature and the high rainfall, which ensured an adequate water supply on most of the farms. During 1947, on the other hand, the persistent high temperatures and drought conditions increased the difficulties of producing milk of good quality. There was serious water shortage on many farms during 1947 : in many cases the quantity of water, apart from its temperature, was entirely inadequate for efficient cooling.

During both 1946 and 1947 the overall results for farms which used a hypochlorite/soda wash for the milk utensils (Groups A and B) were better than for farms relying on other methods involving, generally, final rinsing of utensils with hot water (Groups C and D). The results obtained by farms using hypochlorite (Groups A and B) compared favourably with those obtained by farms using steam (Groups E).

Results for Group A farms, supplied with new milking utensils at the beginning of the trials, were generally better than for Group B farms using their existing equipment. The importance of replacing worn utensils where hypochlorite is used for sterilization is even more apparent when the results for Group A farms are compared with those for farms in Group B that adopted the same method of cooling by immersion.

The relative value of the two methods of cooling may best be judged from the results obtained by Group B farms, about half of which used the immersion method and the other half a surface cooler. During 1946, when most farms had ample water, immersion cooling showed to advantage ; during 1947, however, farms using a surface cooler obtained much better results. Failure of the immersion method during 1947 can be ascribed to the persistent drought. Few of the farms using this method were able to spare more than a few gallons of water for cooling, and it is doubtful whether any real benefit was derived from immersing the churns in the troughs. Without running water there is a danger that milk may be kept at a higher temperature than if the churns are left standing in a cool milk-house ; removing churns from the water for overnight storage is desirable where running water is not available.

The Benefits of Hypochlorite Sterilization The lower incidence of thermoduric bacteria (Table 4) in samples from Group A and B farms, as compared with Group C and D, is direct evidence of the value of substituting hypochlorite sterilization for some of the methods in common use on small hand-milking farms. Farms using steam obtained even better results.

Additional evidence of the value of hypochlorite sterilization of milk utensils is provided by the fact that a proportion of farms in Groups A and B obtained consistently satisfactory results throughout the course of the trials, though there were very few such farms during the hot summer of 1947. Clearly, however, there is need, as with all methods of washing milk equipment, to emphasize the importance of proper application. The results for 1947 show that few farms are able to apply effectively any method when the weather is really warm. If milk is to remain satisfactory until used it would seem desirable, therefore, to stress the need for extreme care in washing and sterilizing milk equipment when, owing to hot weather or shortage of water, or both, it is necessary to reduce to a minimum contamination from the surface of milk utensils.

In these trials the procedure for washing the equipment on Group A and B farms, though simple to apply, was more elaborate after the morning than after the evening milking. Despite this difference, more of the evening milk was of reject quality or of unsatisfactory keeping quality than of the morning milk—a fact which may be ascribed to the earlier age at which morning as compared with evening milk is available for processing with our system of once-daily collection. Producers should be encouraged to give special attention to cleaning utensils after the morning milking. If the morning treatment is effective, rinsing with weak hypochlorite solution should be adequate after the evening milking. In hot weather, however, the morning treatment should also be used after the evening milking.

Information gained from the trials can be summarized as follows:

1. Utensils used in hand milking can be satisfactorily sterilized by hypochlorite. Proper application of the hypochlorite is essential, and the difficulty of sterilizing worn utensils is emphasized.

2. During most of the year, and especially when good cooling is practised, if utensils are thoroughly washed and sterilized after the morning milking a less elaborate procedure should suffice after the evening milking. There is need for even greater care in washing milking utensils during hot weather.

3. Immersion cooling, except where an adequate supply of cold running water is available, is not satisfactory. When using the immersion method without running water, churns should be removed from the cooling trough for overnight storage at the farm.

These trials were undertaken at the request of the Agricultural Improvement Council for England and Wales. The Council is indebted to the many farmers who took part in the trials, to whose efforts the success of the work is mainly due.

The field work was under the direction of the following National Agricultural Advisory Service Advisory Bacteriologists: Mr. H. Barkworth (Hove); Dr. L. F. L. Clegg (Newport, Salop); Mr. J. W. Egdell (Bristol); Mrs. P. M. Hobson (Bangor); Mr. D. A. McKenzie (Leeds); Mr. C. S. Morris (Starcross, Devon); Mr. C. D. Oxley (Cambridge); Mr. S. B. Thomas (Aberystwyth); Mr. C. A. Scarlett (Shardlow, Derby); and Mr. C. H. Westwater (Newcastle-on-Tyne).

National Savings Week—October 22-29

Message from Mr. Tom Williams

The great voluntary National Savings Movement is now well known throughout the land through the active and enthusiastic work of a small staff and many thousands of voluntary workers in both town and country. These have worthily promoted the main purpose of the Movement which was, and still is, to raise the standard of thrift and to show that investing in National Savings is advantageous to the investor and the country. Many millions of small investors in all stations of life have learned during the past difficult years the merits of investing in National Savings.

Unfortunately there is no sign of the end of our difficulties in the immediate future, either nationally or individually. The need for thrift, careful spending, and the building up of reserves is as important now as at any time in the past ten years. So there is still work to be done in giving advice and encouragement to save, both in country and town.

There may still be among farmers, farmworkers or landowners some who have not been persuaded to take advantage of the Savings Movement. It is to you I appeal especially. You have the opportunity to invest profitably and at the same time help your country. You have also open to you a form of public service by becoming a member of the local Savings Committee or a voluntary savings worker. I do ask you to assist the Movement and to consider very carefully the ways in which you may help most. Finally, I earnestly appeal to you to do your utmost to make the "For Britain and a Happy Future" National Savings Week a resounding success. The continuance of a high level of thrift and investment in National Savings is of extreme importance to the country in its efforts to overcome its economic difficulties. Money not immediately required for capital investment on your holding cannot be invested more accessibly, safely and profitably than in National Savings.

APPROVED HYPOCHLORITES IN MILK PRODUCTION

A. ROWLANDS, B.Sc., and W. A. HOY
National Institute for Research in Dairying, Shinfield, Reading

POOR keeping quality of milk can, in most cases, be attributed to contamination with bacteria from the surfaces of utensils that have not been properly washed and sterilized. This fact has long been established. A better appreciation of its significance by producers and others engaged in the handling of milk would inevitably lead to improvement in the general level of keeping quality of milk.

The Milk and Dairies Regulations, 1949, which come into force on October 1, require that all milk utensils "shall as soon after use as is practicable be thoroughly rinsed and washed with or without detergents and, before being used again, shall be scalded with boiling water or steam or otherwise effectively cleansed with an oxidizing or preservative agent approved jointly by the Minister of Agriculture and Fisheries and the Minister of Food."

Prior to 1943 the use of an oxidizing or preservative agent was permitted only for the treatment of milking machines, but provisional regulations issued that year permitted the use of approved substances for the treatment of all utensils, as an aid, but not as an alternative, to boiling water or steam.

Approved Hypochlorites Only an oxidizing or preservative agent approved jointly by the Ministers of Agriculture and Food may be used. At present sodium hypochlorite is the only substance that has been approved under the terms of the Regulations. Exhaustive research and trials in practice have shown that solutions of sodium hypochlorite, when used at the correct strength and applied in accordance with a carefully prescribed technique, may be relied upon to destroy the majority of bacteria on utensil surfaces that have been thoroughly washed and are in a good state of repair.

A number of manufacturers market, under their own trade names, stock solutions of sodium hypochlorite conforming to the requirements imposed. These preparations, and others which may be approved, must be standardized in accordance with the special requirements that are laid down. At the time of dispatch from the manufacturer's premises they must contain 9-12 per cent of available chlorine, not less than 0.7 per cent of sodium chlorate, and not more than 2 per cent of free caustic alkali. Containers must also bear a label indicating the date of dispatch, the manner of storing, and the last date for use. These requirements are designed to protect the user. Any of the approved commercial preparations, if used before the expiry date indicated on the label, may be relied upon to give solutions of the correct strength for disinfection when diluted as directed in a later paragraph. The presence of sodium chlorate in the stock solutions enables a simple test to be applied to detect the addition of hypochlorite to milk.

General Principles Research has shown that the rate at which bacteria are destroyed increases rapidly with the strength of the solution. For example, the treatment of dairy utensils for 1 minute with a solution containing 200 p.p.m. (parts per million) of available chlorine kills the same proportion of bacteria as treatment for 7 minutes with a solution containing only 25 p.p.m. It will therefore be appreciated that the use of solutions at the correct strength is of the utmost importance,

since in practice the time that can be allowed for the treatment of each individual utensil is limited. An increase in strength above 200 p.p.m. does not materially shorten the time for disinfection. With concentrations much in excess of this value there is danger of corrosion.

In the presence of milk residues, rapid loss of strength occurs. To provide the necessary margin of safety, a solution containing about 250 p.p.m. available chlorine should be used, so that its strength does not fall below about 200 p.p.m. before the end of the washing process. Further rapid loss in strength occurs when used solutions are stored, and fresh solutions must, therefore, be prepared at each milking.

Bacteria on utensils cannot be destroyed unless the solution is brought into direct contact with every part of the surface. During treatment, therefore, utensils must be wetted thoroughly with the disinfecting solution. There must also be thorough brushing of the surface, so as to ensure agitation of the liquid in contact with every part of the surface.

Bacteria on clean surfaces can be destroyed as readily with solutions of sodium hypochlorite as with boiling water or steam, but, on surfaces that are covered with a film of milk residues, heat, because of its greater penetrative power, is more effective. A film of milk residues accumulates rapidly on utensils that are washed badly or not thoroughly rinsed after milking. With persistent poor rinsing or washing, a deposit of milk stone gradually accumulates which is extremely difficult to remove with any normal washing process. Bacteria embedded in this film or deposit may escape destruction when hypochlorite solutions are used. Heat, on the other hand, readily penetrates to all parts of the film, and the immediate effect is not so serious where sterilization is by steam or boiling water. Nevertheless, the accumulation of milk residues on utensil surfaces is highly undesirable, since, whatever the method of sterilization, some bacteria survive and will multiply rapidly under the ideal conditions provided in the body of the film.

Milk residues accumulate more readily on utensils that are rusty, cracked, or otherwise in a bad state of repair. The rubber parts of milking machines are also particularly liable to the accumulation of film. Great care is therefore necessary in rinsing and washing if such surfaces are to be maintained in a condition which will respond readily to disinfection with chlorine solutions.

It has been found in practice that farm dairy utensils can be treated most effectively by using the hypochlorite solution as a hot wash in combination with a detergent, a treatment which is referred to as the "chlorine-wash". The detergent in the solution assists the thorough wetting and removal of milk residues, and the chlorine solution penetrates more easily to all parts of the surface. The presence of a detergent in the wash also minimizes the danger of corrosion.

Any mild detergent may be used. Washing soda, soda ash, or any of the proprietary detergents compounded for use in hand washing are all equally suitable.

The efficiency of sterilization of milk utensils with hypochlorites tends to fall off progressively, and ultimately a point is reached when it is no longer safe to rely on this treatment alone. To maintain satisfactory sterilization consistently over long periods, we have found it necessary to treat all utensils with boiling water or steam periodically. The thoroughness of the hypochlorite sterilization determines the frequency with which heat treatment should be applied. Treatment at weekly intervals is desirable in hot weather, but the interval may be longer if the weather is cool. Thorough washing must always precede the heat treatment.

Preparation of Solutions for Use The strength of chlorine solutions is usually expressed as parts of available chlorine per million parts of water. A 10 per cent stock solution of sodium hypochlorite therefore contains 100,000 p.p.m. of available chlorine.

The "chlorine-wash" used for treatment of utensils must contain about 250 p.p.m., and this concentration is obtained by diluting any of the approved stock solutions about 400 times. Details for the preparation of chlorine-wash and other solutions used are given in the following Table.

Chlorine Solutions for Different Uses

	Approximate Strength (*p.p.m.*)	Ounces of Stock Solution to prepare 10 Gallons
Chlorine-wash*	250	4
Chlorine-rinse	60	1
Wet-storage solution for milking machine clusters†	125	2
Solution for udder washing	500	8

*To prepare "chlorine-wash," dissolve ¼ lb. soda ash or other dairy detergent, or ½ lb. washing soda, in 10 gal. hot water (110°–115°F.) before adding the stock solution.

†To prepare "wet-storage solution," dissolve 2 lb. of detergent in the water before adding the stock solution; a detergent compounded for use with aluminium must be used for clusters with aluminium parts.

The stock solution should be stored in a dark, cool place, and a supply for daily use may be handled conveniently in an earthenware jug. In the preparation of solutions for use, the quantities of stock solution must be measured accurately, poured into the required amount of detergent solution or water, and immediately stirred to mix. On no account should the strong stock solution be allowed to come into contact with the hands, clothes, metal utensils, or udder cloths.

Methods of Application Three separate processes are involved in the proper treatment of all utensils. They are: (1) thorough washing to remove milk residues, (2) disinfection by scrubbing in the chlorine-wash, and (3) removal of the chlorine-wash with a chlorine-rinse. The methods of application, however, may be varied for different utensils.

Small Utensils. These include milking pails, cooler and cooler pan, strainer, milking machine pail-lids and fittings, the lids of cans, etc. For effective treatment two troughs are desirable, one being used for processes 1 and 2, and the other for process 3.

It is an advantage to use troughs so designed that during washing utensils are immersed as far as possible in the solution. Where only a few utensils are to be washed, galvanized household baths are admirable.

The actual washing procedure is as follows:

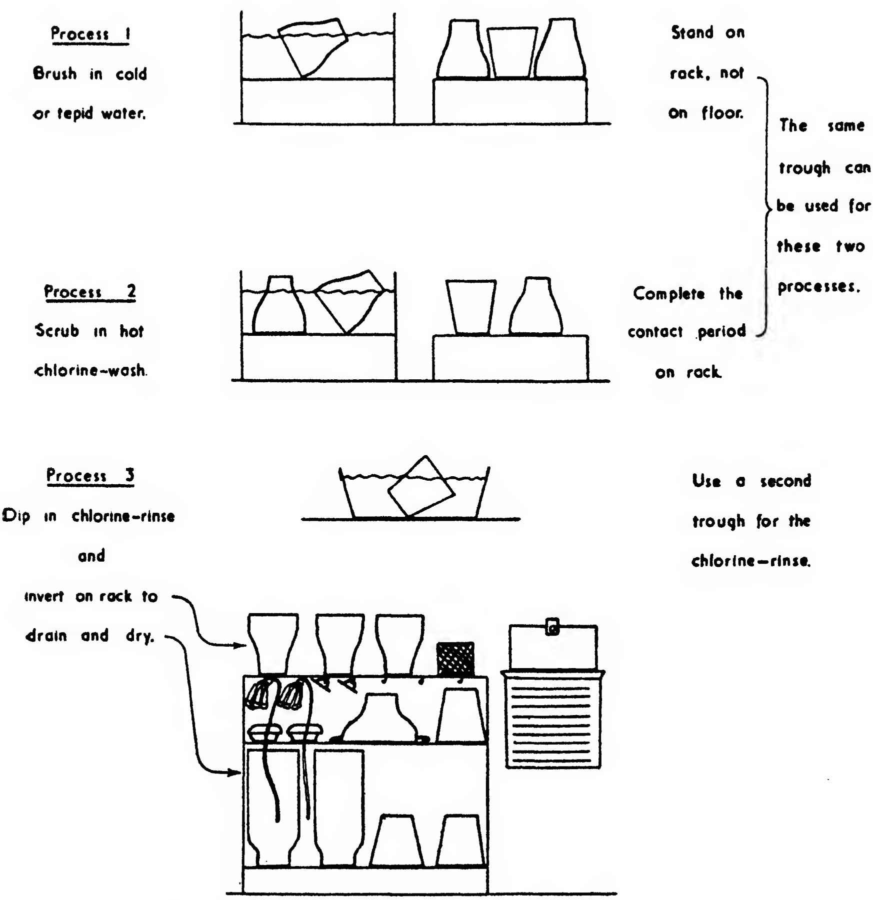
(1) Remove all visible traces of milk and dirt by washing in cold or tepid water. Thorough treatment at this stage increases the effectiveness of the chlorine-wash process. After treatment, place the utensils on a clean rack—not on the floor—while awaiting treatment by the second process, otherwise the dirt picked up will be carried to the chlorine-wash solution. Empty the used water from the trough.

(2) Refill the trough with hot water (110°-115°F.), dissolve the detergent, and add the stock hypochlorite solution. Immerse each utensil in the solution so that all surfaces are wetted, then brush and continue the scrubbing action for at least 1 minute. At the end of this time transfer the wet utensils to a clean rack, where they should remain for at least another minute to complete the total contact period of 2 minutes before the final process.

(3) Prepare " chlorine-rinse " solution in a second trough. Immerse the utensils in this solution to remove the chlorine-wash, and finally invert on a suitable rack in a clean place to drain and dry. (See Plate 1, p. iv of art inset.)

Milking Machine Clusters. The internal surfaces of milking machine clusters are not easily accessible for cleaning, and they readily become coated with milk residues (see Plate 2). They are, accordingly, more difficult to sterilize effectively with chlorine solutions than most other milk utensils. We mention these facts in order to emphasize the extreme care that is necessary if their treatment is to be effective.

Treatment of Farm Dairy Utensils with Approved Hypochlorites (diagrammatic)



Immediately after milking, flush each cluster with at least 2 gallons of cold or tepid water. During this flushing lift the cluster clear of the water several times to induce a scrubbing action : this assists the effective removal of milk from all parts of the cluster. With a wet brush remove all visible dirt from the outside of each cluster.

During treatment with the hot chlorine-wash, immerse the cluster in the solution, taking care to avoid air locks. With the proper brushes, brush each teat-cup and the milk tube thoroughly. Leave the cluster immersed for at least 2 minutes to complete the contact time.

Finally, immerse the cluster in the chlorine-rinse and hang up so that the liquid drains out completely from every part of it.

MILK CANS. Cans need not be treated in the troughs. First brush inside and outside with cold or tepid water, and invert to drain. Add 1 gallon of hot chlorine-wash, scrub all inner surfaces, place the can on its side, and roll so that the solution comes into contact with the whole of the inner surface, including the neck. Leave the solution in contact for at least 2 minutes before finally rinsing with the chlorine-rinse. Invert on a rack to drain. Can lids should be washed with the other utensils.

MILK BOTTLES. For the treatment of milk bottles on a small scale there is no satisfactory alternative to sterilization by steam in a chest. In an emergency, however, it may be necessary to use hypochlorite solutions for their treatment.

The principle of treatment is exactly the same as with other utensils. Often, however, returned empty bottles contain stale milk residues, and their thorough cleansing is then more difficult. Moreover, if these residues are not effectively removed before the bottles are treated in the chlorine-wash, the strength of the wash deteriorates rapidly. It is important, therefore, to bear in mind the vital need to replace with fresh solutions when necessary.

After thorough brushing in clean, warm water, transfer the bottles into a trough containing the hot chlorine-wash, taking care to see that the bottles are filled with the solution. Leave to soak for a few minutes and then brush each one separately by hand or on a mechanical brush. Empty each bottle, immerse in the chlorine-rinse, and, finally, invert in clean crates.

Crate bottoms can be a serious source of contamination and should be cleaned by thorough scrubbing with chlorine-wash in a separate trough before they are used for clean bottles.

UDDER WASHING. Approved hypochlorite may, with advantage, be included in the water used to wash the udders before milking. Its use will give a higher degree of cleanliness than is possible with water alone. This is especially true where the quantity of water is limited or of doubtful cleanliness. It will also help to keep the udder cloths clean while in use, and at the same time disinfect the milker's hands. A solution containing about 500 p.p.m. chlorine should be used (see Table on p. 306).

Wet-storage Treatment of Milking Machine Clusters

This method is widely used in America and, in experiments on a few farms, we have found it satisfactory for the treatment of milking machine clusters. It is simple and more dependable than the chlorine-wash treatment described earlier.

In this method the clusters, after a flush with cold or tepid water following milking, are placed in the special rack and completely filled with the "wet-storage" solution. The clusters are kept full of solution between milkings. At least 10 minutes before they are needed the solution is emptied from the clusters through the milk tube, which is detached from the notch holding it in position in the rack, and the clusters are left to drain (see Plate 3).

Ten gallons of the wet-storage solution (see Table), which is sufficient to treat two clusters twice daily for about three weeks, may be prepared and stored in an old milk can or other closed container. A jug, kept specially for the purpose, should be used to fill the clusters. At the weekly dismantling the clusters should be examined carefully for deposit and thoroughly brushed in hot chlorine-wash, reassembled, replaced in the rack, and filled with solution.

Even with the wet-storage treatment the efficiency of sterilization tends to fall off progressively, and clusters should be treated with boiling water or steam at least once each month.

A Matter of Routine In formulating the above recommendations we have tried to avoid any exaggeration of the difficulties in practice, and the treatments given are, in our experience, the minimum necessary to ensure satisfactory results consistently. To the reader, the treatments recommended may appear unduly elaborate, but once they become part of a regular daily routine it will be found that they are neither difficult to apply nor too time-consuming in practice.

On some farms, where great care is taken to treat all equipment thoroughly after the morning milking, the chlorine-wash process is omitted after the evening milking. The utensils receive only brushing and rinsing with cold water, followed by treatment with the chlorine-rinse. This procedure is followed in the knowledge that the morning's milk is delivered to a creamery within a few hours of production and is available for processing at a much earlier age than the milk produced the previous evening. We have hesitated to recommend the general adoption of this simpler treatment after the evening milking. Whether or not it will prove satisfactory on other farms will depend largely on the effectiveness of application of both the morning and the evening treatments.

The rules for the successful application of approved hypochlorite solutions for the sterilization of dairy utensils may be restated as follows :

(1) See that all utensils and rubber parts are in good condition.
(2) Adhere to a regular routine at all times.
(3) Always use fresh solutions of the correct strength.
(4) Remove all milk and dirt before treatment with the chlorine-wash.
(5) Treat every utensil with hot chlorine-wash for at least 2 minutes.
(6) Follow with the chlorine-rinse, and place the utensils on a clean rack to drain and dry.
(7) Treat all utensils with boiling water or steam at intervals.

KENT INDIGENOUS PERENNIAL RYEGRASS

R. P. HAWKINS

National Institute of Agricultural Botany, Cambridge

PERMANENT grassland in Kent is found on the heavier and more retentive soils in the county, and, except for Romney Marsh, on the poorer types. The more fertile land is devoted to hops, fruit, and market-garden crops, which form such an important feature of Kent agriculture. At least three distinct types of grassland are found in the county.

Romney Marsh Pasture There are a number of marshes situated round the coast of Kent, mainly in river estuaries, which provide first-class grazing. The best known is Romney Marsh, an area of some 59,000 acres in the extreme South, separated from the higher ground of the rest of the county by the Royal Military Canal. The Marsh is alluvial soil and lies below high-water sea level, but it is drained by the canal, and most of the land lies dry throughout the year.

More than half the Marsh is under grass, the stock-carrying capacity of the pastures varying with the fertility of the soil. The world-famous Romney Marsh fattening pastures will fatten from six to ten sheep per acre, and a few outstanding fields fifteen or more during the summer months in a favourable year. During the winter, these pastures carry only two or three sheep per acre. Pastures on less fertile soil are used for breeding, and carry four to six ewes with their lambs during the summer ; others, a proportion of which are not so well drained, carry two ewes or less.

Many botanical analyses have been made of the herbage of these fattening pastures, and, although they naturally vary to some extent, all show a very high proportion of perennial ryegrass (from 60 to 75 per cent of the total herbage), with less than 10 per cent of wild white clover. There are also present small quantities of rough-stalked meadow grass, crested dogstail, *Agrostis*, Yorkshire fog, and field barley grass.

The Marsh is grazed almost entirely by Romney Marsh sheep—one of the larger breeds, heavily fleeced and producing fat tegs at 12-15 months old. This breed is kept practically all over Kent. The ewe flock remains in the Marsh throughout the whole year, and lambs down in April. The lambs leave the Marsh towards the end of August to be wintered on higher ground in Kent and the neighbouring counties, and are brought back in the following March and April to enter the ewe flock or to be fattened off during the summer.

The heavy grazing in summer, followed by light grazing in winter, is now known to have produced the perennial ryegrass dominant swards so characteristic of these pastures. Marsh pastures are kept very closely grazed during summer once active growth has started, which is usually towards the middle of May. The perennial ryegrass which has developed on the Marsh starts growth later in spring than on some of the other types of Kent pastures, and this characteristic is found in the stocks of seed obtained from Romney Marsh permanent pastures.

Late growth in spring, and lateness of flowering which is associated with it, make these marsh types of Kent indigenous perennial ryegrass of particular value when the seed is sown in those parts of the country which normally experience a late spring. The advantages of the early types of perennial ryegrass are lost under such conditions, since it is too cold for them to produce growth early in the year, and active growth ceases at the

end of May or early June when they run up to seed. The late types of perennial ryegrass, on the other hand, continue growing for a further two or three weeks before they, too, produce flowering heads and active growth ceases.

Wealden Pastures The Weald of Kent lies to the north of Romney Marsh, and extends from Ashford westward into Surrey and Sussex. The land is heavy clay, and much of it is inclined to lie wet during winter. Nevertheless it is capable of producing sound pastures of perennial ryegrass and wild white clover of high grazing value. Growth starts somewhat earlier in spring than on Romney Marsh, and stocks of Kent indigenous perennial ryegrass seed derived from Wealden pastures are a little earlier than those from Romney Marsh, but still maintain their mid-season characteristics.

Wealden pastures are grazed by both sheep and cattle, breeding and rearing being more prevalent than fattening. There has been a considerable increase in dairying during the last twenty years or so, and more recently the breeding and rearing of stores for fattening has increased. The Sussex breed of beef cattle is well represented in the Weald of Kent.

Hill Pastures The chalk formation of the North Downs extends the length of the county in the North, widening out to an extensive upland plain east of Ashford towards Dover and Folkestone. The soils on the slopes of the Downs are light and chalky, producing very poor pasture, but most of the soils on the Downs are clay or clay loam with flints and are naturally of low fertility. There are, nevertheless, a certain number of high quality pastures on the hills in which perennial ryegrass predominates. These are saved for seed from time to time, the seed thus obtained being used for sowing down fresh fields in the vicinity ; much of the hill pasture is of poor quality, consisting largely of *Agrostis*, with some perennial ryegrass and wild white clover, and carrying no more than two sheep to the acre. During the last twenty years, much of this poor permanent pasture has been ploughed up and replaced by leys left down for from three to five years. A simple seeds mixture of perennial ryegrass and wild white clover is used for these leys, the seed being obtained in the first instance from a good permanent pasture in the district. The leys are stocked heavily with sheep and cattle.

Heavy stocking and close grazing is traditionally associated in Kent with good grassland management. Even one hundred and fifty years ago, agricultural writers mentioned this system of management and referred to instances where the stock-carrying capacity of fields had been doubled merely by grazing more closely. Heavy stocking with sheep and cattle is common practice throughout Kent, and this probably has produced a type of perennial ryegrass which will withstand such treatment.

The benefit of these heavily stocked leys to the hill farms is seen in the heavier arable crops of corn and potatoes grown after the leys have been ploughed up. Moreover, by taking the ley round the farm and by treading heavier yields of straw into dung with fattening bullocks, the fertility of the whole farm has in many cases gradually been raised ; the benefit to the leys sown subsequently is reflected in their higher stock-carrying capacity. Sheep breeding and rearing, with some dairying, is normal practice in this area ; but on many farms with well-managed leys, not only are sheep bred and reared, but tegs are being fattened from these hill ley pastures. Some of these leys are carrying from eight to ten sheep per acre during the grazing season.

Perennial Ryegrass Seed Production The system of management where a crop of perennial ryegrass seed is to be taken is the same throughout the county. Before taking a crop of seed, the pastures are grazed in spring until the end of May or early June. The livestock is then removed, and the field shut up until after the crop of seed is harvested. By this treatment the growth of wild white clover is encouraged, and the crop harvested for seed is a mixture of perennial ryegrass and wild white clover in varying proportions. In some years both will ripen at the same time ; otherwise it is harvested when the crop which predominates, whether perennial ryegrass or wild white clover, is fit to harvest.

It has long been the practice among Kent farmers to save seed from time to time from their best pastures. Arthur Young (1792) refers to the practice in Kent of laying down fields to grass with seed saved from "a meadow kept until ripe". He states that these gave better results than fields sown with commercial seeds. At that time the produce of these old pastures was valued for its natural grasses—chiefly perennial ryegrass—and the white clover was regarded as of secondary importance. In more recent years, with the demand for wild white clover, Kent indigenous perennial ryegrass has been regarded as a by-product of wild white clover seed. It is recognized that both the perennial ryegrass and the wild white clover are of very great value for sowing land down to grass, and some of the other strains of grasses and legumes found on these pastures may prove of value in seeds mixtures of the future. That the value of Kent indigenous perennial ryegrass is appreciated outside the county of Kent is reflected in the higher price it commands on the open market.

Graziers do not like taking seed from permanent fattening pastures, because they consider it reduces the grazing value of the pasture for several years afterwards. It is only occasionally that seed from these pastures becomes available, and it is then used for sowing down fresh land in the county. For many years Kent indigenous perennial ryegrass seed has been mainly the produce of leys sown with seed which came originally from old pastures of repute.

Investigations at Cambridge In 1944, Kent growers explored the possibility of introducing measures to protect the best stocks of genuine Kent indigenous perennial ryegrass growing in the county. The National Institute of Agricultural Botany at Cambridge was asked to investigate the problem and to assist the growers to formulate a scheme to achieve this end.

Some fifty stocks of perennial ryegrass, reputed to be genuine Kent indigenous, were sent to the Institute, and detailed investigations into type were made during 1946, 1947, and 1948. In July, 1947, and again in July, 1948, the Institute co-operated with growers in Kent in making a survey of Kent pastures with a view to selecting the best from which foundation stocks could be secured for the proposed scheme. More than a hundred selected pastures were examined, and seed from the best of them was sent to the Institute for further investigation.

As a result of these investigations the following conclusions have been drawn :

1. Kent indigenous perennial ryegrass is a distinct type of perennial ryegrass of mid-season maturity. It flowers some ten to fourteen days later than early types, such as Irish, Ayrshire, Eaver, and Aberystwyth S.24, but is some ten to fourteen days earlier than the late types as represented

by Aberystwyth S.23 stock seed. It has a semi-prostrate habit of growth, and this characteristic enables it to be distinguished from other types flowering about the same time.

2. It was found that there was rather more variation among stocks seeded direct from old pasture than among those obtained from leys. Stocks seeded direct from Romney Marsh fattening pastures were a week or more later than those from the Weald or from the hills. These latter approximated very closely to the characteristics of the ley types. The characteristics of Kent indigenous perennial ryegrass stocks obtained from leys appear to have been acquired as a result of the Kent system of management for seed. Stocks obtained originally from permanent pasture but seeded from leys for (in some cases) as long as twenty years still retain the mid-season characteristic, and persist for at least five years in Kent pastures. The possibility of stocks derived originally from Romney Marsh, from the Weald, or from hill pasture being of particular value for certain conditions is being investigated further.

3. Kent indigenous perennial ryegrass has a higher proportion of non-flowering to flowering shoots than is found in many strains of perennial ryegrass. This not only produces more leaf, but enables it to compete successfully with wild white clover and thus provide a balanced sward of perennial ryegrass and wild white clover. The closer and more leafy sward produced by Kent indigenous perennial ryegrass is strikingly demonstrated when it is grown alongside some of the earlier types of perennial ryegrass, both sown with wild white clover and subjected to the same grazing and management. The difference is most marked after the second year.

4. Kent experiences a more "continental" climate than many parts of this country. While the winter cold is not extreme, the springs are frequently cold and late, and there is often drought in April and May. The rainfall over most of the county is less than 30 inches per annum, while in some parts of East Kent and Romney Marsh it is 25 inches. The climatic conditions under which Kent indigenous perennial ryegrass has developed appear to render it particularly suited to the drier climate of the eastern side of Britain and to the cold late springs experienced in the East and North-East of Scotland.

Certified Kent Indigenous Perennial Ryegrass Early in 1949 the Seed Production Committee of the National Institute of Agricultural Botany at Cambridge approved a scheme for certifying selected stocks of Kent indigenous perennial ryegrass saved from both permanent pasture and from leys.

The scheme is administered by the Kent branch of the National Farmers' Union through its Secretary, Mr. C. C. M. Taylor, 50A King Street, Maidstone. Certificates are issued in respect of crops of perennial ryegrass grown from stocks which have been approved by the Seed Production Committee as being genuine. To qualify for approval, the stocks must have originated from selected pastures in Kent and have been examined for trueness to type in a growing on test at Cambridge. The crops grown from these stocks are inspected by a panel of growers, merchants, and technical men who must report favourably before a certificate can be issued.

Kent growers, however, are anxious that only seed with a high standard of purity shall be sold under their scheme. They have, therefore, appointed approved merchants to handle the seed after it has been threshed, and the certificate is issued only after the seed has been cleaned by one of their approved merchants to a sufficiently high standard of purity.

The certificate issued by the Kent National Farmers' Union states that, from evidence submitted to them, they are of the opinion that the crop from which the seed was harvested was a genuine stock of Kent indigenous perennial ryegrass. Combined with this is a declaration by the grower and the approved merchant that the seed was, in fact, harvested only from the crop inspected and grown only from a stock approved by the Seed Production Committee.

With a guarantee of this nature, farmers who find this type of ryegrass suits their conditions and system of farming should be able to buy with confidence. The certificate assures them that they are buying the same type from year to year and that, subject to seasonal variation, they will get similar results from their leys. The scheme should thus benefit both the grower in Kent and the farmer who buys Kent indigenous perennial ryegrass seed.

Acknowledgments are gratefully made to Mr. G. H. Garrad and the members of his staff in Kent, and to members of the National Agricultural Advisory Service in that area, for their advice and assistance during the course of this investigation and in drawing up the report. Thanks are also due to growers and mer chants in Kent who have given freely from their store of local knowledge.

THE PROBLEM OF LODGING

Professor H. IAN MOORE

Seale-Hayne Agricultural College, Newton Abbot, Devon

IT is often said that laid corn never brought a farmer to bankruptcy. This may or may not be true ; what is certain is that each year lodging causes serious financial losses to farmers, not only directly in the loss of grain and the lowering of quality, but also indirectly in the disorganization and delay it entails at a critical time. Delay one season may prejudice the chances of success with the next year's crop.

Lodging seems to be more widespread now than formerly. This has been ascribed to various factors, such as the more general use of nitrogenous fertilizers, the shortage of potash, and the development of clover leys. What is the evidence ? Over the past fifteen years detailed records of a large number of fields of wheat, barley, and oats have been analysed, and where lodging occurred an effort has been made to ascertain the cause. The following Table shows the causes of lodging in 500 fields covering 7,350 acres :

Cause of Lodging	No. of Cases	Percentage of Total Cases
Storm, flooding, wind, etc.	105	21
High fertility of soil	35	7
Unsuitable variety, e.g., too weak or long in straw	155	31
Excessive nitrogenous manuring	20	4
Disease, e.g., foot rot	25	5
Lack of phosphate or potash	30	6
Cultivation deficiencies	35	7
Excessive seed rate	35	7
Unchecked winter proudness	45	9
Obscure causes	15	3
	500	100

It is appreciated that the method of classifying the causes of lodging under the ten headings is entirely arbitrary and that the diagnosis might conceivably vary with different investigations. It was done, however, by the writer in consultation with the farmers concerned, and before the final verdict was pronounced great care was taken to elucidate all possible causes of lodging.

Preventive Measures The most striking fact emerging from the scrutiny of these records is that nearly 80 per cent of the lodging was capable of being controlled. It is true that the survey covered farms in Yorkshire and Lincolnshire only and may not, therefore, be applicable to other parts of the country, but all the cases were recorded in the course of routine advisory work and were in no way exceptional. It is probable that some of the lodging caused by adverse weather would not have been experienced had very stiff-strawed varieties been grown, but it is intended to deal only with those cases of lodging where the remedy is fairly clear.

The fact that over 30 per cent of the lodging was considered to be due to the choice of an unsuitable variety indicates the supreme importance of choosing carefully the one likely to be the most suitable. It also emphasizes the value of the field trials carried out by the National Institute of Agricultural Botany and the need for more demonstrations by the National Agricultural Advisory Service. There is little doubt that the selection of stiff, short-strawed, early-ripening varieties in these instances would have prevented most of the trouble. The indiscriminate use of Little Joss under conditions which would have taxed the standing powers of, say, Yeoman is responsible for many cases in this category. In only 7 per cent of the fields was the fertility of the soil so high that it could confidently be said that lodging was inevitable. Here, obviously, the cropping was at fault: had potatoes or sugar beet been grown to tap some of the fertility before growing a cereal, the result might have been very different. Undoubtedly too, the cropping was at fault in those instances where disease caused lodging, and a stricter adherence to rotational cropping might have avoided the trouble.

FERTILIZERS. Lack of phosphate was suspected in twenty fields. The root system was abnormally poor and soil analysis confirmed phosphate deficiency. As for potash, there is little experimental evidence to indicate the effect of this plant food on the standing capacity of cereals, but only lack of potash could account for the lodging noted in the remaining ten cases in this group.

In the majority of the instances where lodging could be attributed to the use of nitrogen, it appeared that the main cause of the trouble was wrong timing of the dressing. Mostly, this was made in late March or early April, when the effect would be to increase the length of straw and perhaps the number of side tillers also, whereas had the application been delayed until mid-May or even later, the size of head—and hence the yield of grain—would have been increased without materially affecting the straw. Confirmation of this was obtained from a number of fields in the same counties where late application of nitrogen is standard practice.

SOWING AND CULTIVATION. Excessively high seed rates caused lodging in 7 per cent of the cases. Modern techniques, such as the use of mercurial seed dressings and the placement of fertilizers close to the seed tend to ensure a much higher seedling survival than was expected by the last genera-

tion of farmers. There is evidence that in many cases a reduction of 15-20 per cent in seed rates would promote better plant development by admitting more light and encouraging a stronger root system.

It is always difficult to diagnose mistakes in cultivation and assess their effect on the crop concerned, but puffiness of the seedbed, irregular seeding depth and bad drainage seemed obvious faults. Much more attention should be given to the spacing of cereals.

Winter proudness should not be allowed to cause lodging. Grazing off the excessive leafage with dairy cows or sheep, checking the growth by burning with sulphuric acid, or even mowing and leaving it to rot away are well-known ways of obtaining valuable early spring keep and at the same time effectively countering lodging. Observations in Yorkshire indicated that grazing up to the time when the "flag" was 8 inches long was feasible without adversely affecting the yield of grain. Uniform grazing is important, and the soil must, of course, be reasonably dry. Grazing in this way not only shortens the straw by 2–8 inches, but may also delay ripening by two or three weeks ; obviously this point must be borne in mind in a late district.

It appears from this analysis that most of the lodging of cereals is preventable, and, in view of the high cost of labour and the serious shortage of skilled workers, every effort should be made to eliminate the trouble.

INFESTATION OF FARM-STORED GRAIN

MANY kinds of pests, both insect and mite, live in farm buildings, feeding on stored farm produce and animal feedingstuffs. They find their way into the buildings in many ways, one of the commonest being on secondhand or hired bags used for the wheat after combine harvesting or in which the wheat is sent for drying. Many of the bags are used for grain year after year, and the pests survive in the seams, living on residues of dust and grain, and emerge ready to attack when the bags are used again. Once established in a barn or granary, they live on any suitable farm produce, but they can also exist for considerable periods without food ; they often escape removal by ordinary cleaning processes by their habit of hiding in floor or wall cracks. The most important of these pests are :

Weevils	(Grain Weevil—*Calandra granaria* L.)
Grain Beetles	(Saw-toothed Grain Beetle—*Oryzaephilus surinamensis* L.)
	(Flat Grain Beetle—*Laemophloeus minutus* Oliv.)
	(Red Rust Grain Beetle—*Laemophloeus ferrugineus* Steph.)
Flour Beetles	(Flour Beetle—*Tribolium castaneum* Hbst. and *Tribolium confusum* Duv.)
Bean Weevils	(Bean Weevil—*Acanthoscelides obtectus* Say.)
	(Bean Beetle—*Bruchus rufimanus* Bohem.)
Mealworms	(Yellow Mealworm—*Tenebrio molitor* L.)
	(Dark Mealworm—*Tenebrio obscurus* F.)
Moths	(Brown House Moth—*Hofmannophila pseudospretella* Staint.)
	(White-shouldered House Moth—*Endrosis sarcitrella* L.)
Mites	(Flour mite—*Tyroglyphus farinae* De G.)

The presence of these pests is indicated in several ways :

1. Hollowed (or holed) grains, peas, beans, or cake.

2. The matted surface (webbing) or fine threads or cocoons spun by moth caterpillars.

3. The brown dust and minty smell associated with mites.

4. The heating of grain or meals. If grain is too wet (more than 17 per cent moisture) it will normally heat on storage. But even comparatively dry grain will heat if insects are present—the insects being the cause of the heating. The activities of a few insects will bring about a slight rise in temperature which will stimulate further insect (or mite) activity, causing additional rises in temperature. In this way temperatures as high as 120°F. may be reached. Any disturbance of such infested grain will only increase the trouble by spreading the insects. Expert help should, therefore, be sought in such cases.

5. If a handful of grain is dropped into a bucket of water, the insects (and damaged grains) can be seen floating on the surface.

Appearance and Habits GRAIN WEEVILS attack all kinds of grain. They are small, blackish beetles about 3/16 inch long with a distinct snout. The female may lay up to 100 eggs just beneath the seed coat of the grain, and these take about 10 days to hatch into minute white grubs which bore their way into the grains, gradually hollowing them out, so that when they pupate nothing but a hollow shell remains. Grains holed or hollowed out in this way are indications of grain weevil activity. The adult weevils, at first rather reddish-brown in colour, escape from the damaged grains, mate, and lay more eggs ; there may be three or four generations in a year, and under favourable conditions a small population may give rise to a heavy infestation in a short time. They are not killed by winter temperatures, and an infestation may therefore be carried on from one year to the next.

GRAIN BEETLES, FLOUR BEETLES AND MEALWORMS. Except for the mealworm beetle, which is ½ inch long and dark brown, these are small beetles about the same size as grain weevils, but flatter. They have no snout and are reddish-brown in colour. Both flour and grain beetles lay their eggs among the grains ; the small, light-coloured, wire-like grubs that emerge do not live inside the grains but wander and feed freely among them ; when fully grown they pupate and the adults emerge in due course. They attack meals, cattle cake and similar materials more readily than whole grains.

BEAN WEEVILS attack peas and beans ; they are larger than grain weevils about ⅛ inch long), greyish-brown in colour, and more globular in shape. The female weevil either lays her eggs under the seed pods before harvesting or scatters them among the stored seeds. Each female weevil will lay up to 200 eggs, which hatch into grubs that bore their way into the seeds, living and feeding inside the seed coat until fully grown. They then pupate just below the skin so that the latter looks like a semi-transparent window ; through this window the adult beetle finally emerges leaving a small, round hole. The presence of these windows and holes indicates a bean weevil infestation. There may be up to four generations of weevils in one year.

The bean weevil will breed indefinitely in dried beans and peas. It should not be confused with the bean *beetle*, which attacks beans during growth and often emerges from the dried beans in store. The bean *beetle* will not continue to attack the dry stored beans, but must escape to the

fields in order to lay its eggs on the growing crop. To ensure accurate identification and expert advice, you should contact the advisory entomologist for your area as soon as you discover that beans in store are infested.

MOTHS. Two moths commonly found in farm buildings are the brown house moth and the white-shouldered house moth. They will attack grain, peas, beans, and almost any sort of animal feedingstuffs. The brown house moth is about ½ inch long and, as its name implies, is brown in colour, speckled with black. The white-shouldered house moth is slightly smaller and has a white head and forepart of the body. Both moths lay their eggs on the feedingstuffs; these eggs hatch into small, white caterpillars with brown heads. The caterpillar is the destructive stage; it eats voraciously and spins a fine thread over any surface on which it crawls, so matting together the foodstuff and fouling far more than it actually eats. When it is fully grown it is about ½ to ¾ inch long, and after finding a sheltered corner it spins a cocoon in which to pupate. Collections of these cocoons containing brown leathery pupae are found around the neck or in the ears of infested bags, and particularly on the surfaces where two bags are in contact. Adult moths emerge from these pupae, mate, and lay their eggs on any food available.

MITES are very small, whitish creatures barely visible to the naked eye, but forming a brownish dust when present in large numbers and producing a rather musty or minty smell. They attack all kinds of grain and many kinds of animal feedingstuffs. Mites multiply very rapidly; the female lays 20–30 eggs, and the life cycle can be completed in 17–18 days. They are very dependent on the moisture content of the food in which they are living; they cannot thrive if this is less than 12 per cent, but any increase in moisture content is followed by an increase in their rate of development. Being so small they are very easily carried from one food to another by insects, mice, or men. They cling to the surface of bags and can live in small deposits of grain or grain dust in floor cracks and corners, so that very careful cleaning is of the utmost importance.

It should be clear, from the descriptions of the life cycles of these pests, that there can be no spontaneous generation of insects or mites in wheat or any other foodstuff. Except for bean weevils, they do not occur in the fields, so that if insects or mites are found, the commodity must at some stage have been in contact with infested food, bags, or premises.

Routine Precautionary Measures

1. Buildings should be cleaned thoroughly and regularly. Whenever one lot of grain or animal feedingstuffs is removed, the place where it was stored should be carefully cleaned; moth cocoons should be scraped off the walls and all loose debris in cracks and corners removed. The material so collected should be burned immediately.

2. After cleaning, before any new material is put into store, the space should be treated with an insecticide, as described later in this article.

3. Buildings should be kept in a good state of repair. If they are constructed for the purpose for which they are used, i.e., have not been adapted, certain modifications in design and finish are possible which reduce the number of places where pests can hide and breed. Owners will find *Farm Buildings* (Post-War Building Studies No. 17)* of assistance when buildings are being constructed or modified.

* Obtainable from H.M. Stationery Office or through any bookseller, price 3s. (3s. 4d. by post).

Any wall or floor dampness must be remedied by repairing the roof, gutters, etc. Wall and floor cracks must be filled in—a smooth concrete surface gives a satisfactory finish—and there must be adequate ventilation.

4. There should be no form of artificial heating. Even a glass or corrugated iron roof will be hot in summer, and a rise in temperature in the building will increase the rate of development of an infestation.

5. All old stocks should be removed or completely segregated from new stocks so that insects and mites cannot crawl or fly from one to the other.

6. All stocks should be used in strict rotation.

7. Stacks of bagged material should never be piled against walls, out of the cracks of which insects may crawl, or on which moisture condenses with changes in weather. A narrow gangway should be left between bags of different commodities.

8. Whenever possible, meals, cake, and other feedingstuffs should be stored apart from the grains, preferably in a different building.

Control Methods It is most important to realize that most of the pests mentioned in this article cannot readily be killed by starvation or cold. Other methods of control must, therefore, be used—the choice depending largely on the types of pests present and their whereabouts. Before taking control measures, therefore, a thorough examination should be made to determine the species present and to discover the true extent of the infestation. Special attention should be paid to gaps in walls, and dead spaces between walls and weather-boarding or between bins, where spillage collects and forms a good breeding ground. Such spillage, and any other materials harbouring infestation, should be cleared up before using sprays or other control measures.

If grain or similar material in bags or bins is infested, it should be dealt with first ; it will deteriorate if allowed to stand. In any event, it will not be possible to obtain effective control in the rest of the building if infested grains and feedingstuffs are allowed to remain. Unless they can be consumed immediately they may have to be treated by heat or by insecticide.

Treatment of Infested Grains and Feedingstuffs HEAT. Heating to 140°F. for 15 minutes is sufficient to kill the insects concerned. In using this method, however, satisfactory results are obtained only if the required temperature is reached throughout the infested material. Although this is not difficult with a very small quantity of material (e.g., a few pounds of grain), it is not easy to achieve with larger quantities unless special apparatus is available. The apparatus must be used with care, because overheating may cause damage to the germinative powers of seeds or to the baking qualities of bread grain. Such heat treatment can be applied by passing the grain through any standard drier.

At the lower end of the temperature scale, it is not possible to rely on cold winter temperatures to effect sterilization. Although their activities may almost stop for a time, most insects and mites can withstand low temperatures. Moreover, temperatures in piles of infested grain are usually much higher than those prevailing outside, so that insects there are not generally affected by seasonal changes.

FUMIGATION. Quantities which can be put into tight containers, such as metal grain bins, dust-bins, etc., can be fumigated readily with liquid mixture

containing three parts of ethylene dichloride and one part of carbon tetrachloride. This is a non-inflammable mixture which can be obtained ready made from dealers.

The infested material is put into the bin. The measured dose is poured on to a piece of sacking placed on top, and the lid sealed to prevent leakage of the vapour. After 48 hours the bin is opened. Care must be taken not to breathe the concentrated vapour or to spill the liquid over oneself: however, small treatments (e.g., of up to a few hundredweight) can be carried out without much risk.

The amount of fumigant required depends on the temperature, the material being treated, and the species present. The following doses should give a useful guide:

Temperature 60°F.	(1)	Grain	8 lb. (5 pints) per ton.
	(2)	Meal (Bran, wheatings, etc.)	20 lb. (12½ pints) per ton.
	(3)	Empty bags	9 lb. (6 pints) per 100 bags.

The gassing of larger quantities of produce or of whole buildings is more complicated. Very toxic gases, such as hydrogen cyanide, are normally used, and experienced operators have to carry out the work. In addition, buildings must be in excellent condition, since leakages will prevent effective treatment. Commercial fumigating organizations are available to undertake this type of work where necessary.

Grain in farm silos can be fumigated, depending on the soundness of the structure. As recommendations can be made only after expert examination, you should contact the nearest inspector of the Infestation Control Division (if necessary, through your advisory entomologist).

OTHER INSECTICIDES. Various insecticidal dusts have been used on infested grains. Those containing DDT or benzene hexachloride (BHC) are easy to use and most effective, but they can be recommended only for the treatment of seed grains. They must not be used on human or animal foodstuffs, as their degrees of toxicity to man and animals are not, at present, known with certainty.

Treatment of Barns, Bins and other Structures

Chemical measures are not likely to be of much use until infested material has been dealt with and thorough cleaning carried out. Insecticides have little chance of acting upon insects and mites hidden below cobwebs, sweepings, grain, or flour in floor cracks, etc.; the removal of such material alone may dispose of further trouble.

Dusts, sprays and smokes are all suitable for structures: the choice between them depends largely on the conditions in a particular case.

DUSTS. In buildings of loose wooden construction, or in bad repair, dusts are particularly suitable. They may be brushed into floor cracks or into dead spaces below floorboards or bins. They may also be blown into hidden spots, such as those between bins and weather-boarding. Make sure that all possible hiding places are treated; better results are obtained by using small quantities of insecticides this way than by applying excessive amounts in one or two spots. Only small quantities of the recommended dusts are necessary in each locality; hand bellows and small horticultural dusters have proved useful in applying them. Dusts containing DDT (e.g., 5 per cent) or BHC (e.g., 0.5 per cent gamma BHC) are readily available: they are suitable for this type of use because they retain their activity for a long period.

SPRAYS. Various types of spraying material are available. For application to hard, non-absorbent surfaces, or where water would cause damage,

those in oil are suitable. The insecticide is applied as a light layer or film to all surfaces where the insects are seen or where they are likely to walk. It is best to use a mechanical (or paint) sprayer for big jobs ; but a knapsack or other type of hand sprayer may be used. Insecticides for use in this way are readily available from dealers. Those containing pyrethrum are particularly suitable because they may be used almost anywhere without risk of contaminating foodstuffs ; if grain is to be sprayed directly, however, a suitable oil base must be chosen. (Sprays containing more than 0.5 per cent pyrethrum in an oil similar to refined medicinal paraffin are available and can be recommended for the latter purpose.) Sprays containing DDT (e.g., 5 per cent) or BHC (e.g., 0.3–0.4 per cent gamma BHC) are also effective, but, as previously stated, they must be used with greater care. In most cases spraying may have to be repeated once or twice to obtain complete control.

For absorbent surfaces, such as those of brick or plaster, or covered with whitewash, sprays made up from special dispersible powders are suitable. They are prepared by mixing with water in the same way as limewash and can be applied through a sprayer, or even through a stirrup pump with a fairly fine nozzle. Such powders, containing DDT, are available from insecticide dealers. Those containing a high proportion of DDT (e.g., 33 per cent) are best, because in many cases it is more difficult to kill grain insects than it is to kill flies, for which these materials are often sold ; it is advisable, therefore, to obtain a brand which carries specific directions for use against grain pests. Such powders should not be mixed into wall-washing mixes, e.g., limewash : if the wall must be limewashed the insecticide wash should be applied afterwards to ensure that it rests on the surface. Walls treated in this way retain their toxic dressing for many weeks, unless they become covered by dust or the insecticidal layer is removed by frequent brushing.

SMOKES. Smokes are particularly suitable for lofty, awkwardly shaped buildings, or bins, which would be impossible to cover by direct spraying. Provided residues of stock and other debris in which insects may hide are removed, and that the building can be sealed reasonably well, these smokes are valuable for controlling the pests mentioned in this article.

The canisters, containing DDT or BHC, can be obtained from dealers, in various sizes suitable for different structures. They carry detailed recommendations for dosage and use.

This article is intended only as a general guide on the infestation problem. Officers of the Ministry are available, on request, for advice in individual cases.

COMBINED HARVESTERS AND THE 1949 HARVEST

The harvesting of this year's grain crop of more than a million tons has been the easiest, earliest and speediest for many years; 2,500 new combined harvesters were in action, bringing the total number in use in the United Kingdom to about 9,000. In 1939 there were only 150 combines on British farms. It is fairly certain that the numbers will go on increasing for some years. Until 1945, when home production of these machines started in earnest, farmers had been dependent on American machines. In the first six months of 1949 home production and imports were responsible for roughly equal contributions to the total supply, and next year home production will again show a big increase.

The combines in use in Britain vary greatly in size, the smallest being a 3 ft. 4 in. cut machine, a few of which were imported in 1943. Of the 9,000 in use this year 1,540 had a cut of 5 ft. 6 in. or less ; 3,520, 6–8 ft.; 1,270, 8 ft. 6 in.–9 ft.; and the remainder (2,670) 10–12 ft.

FEEDING SUGAR BEET TOPS GREEN

P. N. Harvey, M.A.
Norfolk Agricultural Station, Sprowston

BEET tops consist of the green leaves and a proportion of the root (the "crown"). The weight per acre is, on the average, almost equal to the weight of washed beet delivered to the factory. When wilted, the tops lose about a third of their weight. Analyses show that they contain 15-17 per cent dry matter, which is rich in protein and sugar. They are, therefore, a succulent feed and a substitute for the usual root crops.

Nutritive Value Theoretically the nutritive value of beet tops should, ton for ton, be better than swedes or mangolds; the latter, however, can be fed with less waste, and feeding trials have shown that for both cattle and sheep a ton of tops is only equivalent in feeding value to a ton of swedes. The protein content is slightly higher, and the fibre content slightly lower, than that of kale; beet tops are, in fact, a good substitute for kale, especially from early October until Christmas. Beet tops may vary considerably in nutritive value according to:

1. The proportion of leaf to crown. The crown contains most of the feeding value of the top, but any advantage gained by overtopping the beet is far outweighed by the loss of root tonnage delivered to the factories.

2. The time between topping and feeding, which may reduce the sugar content of the tops by as much as 1.5 per cent for each month of delay.

3. Decay due to exposure in wet and frosty weather. Whilst it is desirable, for reasons explained later, to allow the tops to wilt before feeding, it is equally desirable to feed them before decomposition begins—if possible within two weeks of topping. The effects of exposure can be minimized by leaving the tops in heaps on the field rather than in rows. Heaping should be done at the earliest opportunity, especially from November onwards, when there is danger of frost and snow; otherwise the tops may deteriorate rapidly and be difficult to find after a fall of snow. But whatever the weather, beet tops piled in heaps will remain green for a considerable period, and they are also less likely to lose their food value by rooting in the surface of the ground.

4. Contamination by soil. If it is the intention to feed the tops, it is most important that they be kept as clean as possible, because sand introduced into the digestive system of the stock can be highly dangerous: contamination occurs mainly through careless knocking of the beet, carting over the tops, and from rain splashing over the rows or heaps.

Beet tops contain certain impurities unwanted in the process of extracting the sugar. Some of these may give rise to taints in milk; others may cause stock to scour very badly if fed in excess. The chief laxative in beet tops is oxalic acid—amounting to 4.5 per cent of the ash. By allowing the tops to wilt before feeding, the concentration of oxalic acid is greatly reduced, and, as an additional precaution, about ¼ lb. precipitated chalk should be fed for every 250 lb. of tops. The chalk combines with the remaining oxalic acid, forming insoluble oxalates which are harmless to the stock.

Feeding to Sheep There are several advantages in feeding beet tops to sheep: collecting and carting are unnecessary; the supply of plant nutrients is maintained at least at the same level as would result from ploughing in the tops, and the value of the tops is cashed earlier; also, both the feeding value through the liveweight increase of the sheep and the manurial value of the tops are recovered.

A mature sheep, according to its size, will eat 14-21 lb. of tops daily. It is fairly safe in a sheep-feeding programme to allow one acre of sugar beet tops per 100 sheep per week. Most flockmasters prefer to fold the ewes on the tops; they are perfectly safe and good feed for fattening sheep of either sex, and urinary troubles with male sheep are not common. The flock will live well on beet tops from October to January, with little more than a good supply of hay and a run out to grass until lambing is within sight.

Sheep do not fatten quite so quickly on tops as on swedes; a trial at the Norfolk Agricultural Station in which 140 sheep took part in three successive years produced weekly liveweight gains of 2.7 lb. on swedes and 1.9 lb. on tops, from theoretically equivalent rations. Sheep consume the tops better if they are aerated a little before feeding by forking them out of the rows where they have been lying since topping. A supply of water is also appreciated.

Feeding to Cattle If required, a 10-cwt. bullock will consume 100 lb. of tops daily; smaller cattle less in proportion. As with sheep, the liveweight increases in cattle-feeding trials at the Norfolk Agricultural Station show that, when fed in theoretical equivalence, beet tops yield smaller liveweight gains than swedes, the comparison being 1.7 lb. daily per animal on tops and 2 lb. on swedes.

It is rarely possible to finish fattening cattle on beet tops, for the supply of fresh tops generally runs out early in the New Year, necessitating recourse to other roots, beet top silage, or dried beet pulp; but beet tops are valuable for feeding in the early stages of fattening, especially when cattle on autumn grass are waiting to go into their winter fattening quarters. During that period an average increase of 1.5 lb. daily has often been recorded at the Norfolk Agricultural Station from cattle on grass, hay, and beet tops.

All ruminant animals consume tops with relish and benefit. Care must, however, be taken with dairy cattle, otherwise taint due to traces of betaine may develop in the milk. Cows in milk should not receive more than 42 lb. of tops daily; they should never be fed in the cowhouse, but on pasture immediately after the morning milking. Rather than rely entirely on beet tops for feeding dairy cattle, it is better practice to use the tops as far as possible for the dry stock, leaving kale and mangolds for the milking cows. No taints in milk, however, should develop if small quantities of tops are fed as suggested.

Cattle need a good supply of water, for beet tops are a sweet and thirsty feed—six gallons was the average daily consumption of water per animal in the Norfolk Agricultural Station bullock-feeding trials. Cattle troughs must be cleaned out constantly when feeding beet tops.

The failure of beet tops to produce results in practice in accordance with their analysis has been noted both with sheep and bullocks. Unless the ration of beet tops is small it is not usually possible to make up the leeway by feeding more tops. Additional concentrated food will do so, however; the extra quantity for a 10-cwt. fattening bullock on 100 lb. of tops daily is equivalent to about 1½ lb. of oats or barley per day.

SOME IMPRESSIONS OF NORTH AMERICAN AGRICULTURE

P. J. MACFARLAN, B.Sc. (Agric.)
County Agricultural Officer, Devon

Mr. Macfarlan was Assistant Agricultural Attaché at the British Embassy, Washington, from May, 1946, until July, 1949.

MY first look at farming in America was from the window of a train in May, 1946, during the journey south from New York to Washington. I saw small areas of cultivated land growing rather miserable crops of small grains, maize, potatoes, or vegetables, odd pieces of rough pasture dispersed among large woods, and derelict, weed-covered fields, which had obviously been cultivated at some time in the not-too-distant past. There were few obvious changes throughout the 200-mile journey. To one accustomed only to the intensive and varied farming pattern of Britain, this was a depressing scene, but I soon found out that it was not typical of the continent as a whole. It brought out in a vivid way, however, the first great contrast between the agriculture of Britain and America, namely, the vastness of the country, the abundance of land in North America, and the low intensity of the farming.

Since that first journey, it has been my good fortune to have been able to travel fairly extensively in North America and to observe something of the very varied farming systems. While there are many interesting lessons to be learned from the wheat and cotton belts of the central and southern states, from the ranching areas of the high plains and mountain states, and from the irrigated regions in the South-West, I shall, of necessity, have to limit this discussion to regions where climate, size of farms, type of farm, and other factors are more comparable with those in the United Kingdom. These are Eastern Canada, the north-eastern and Great Lake states of the U.S.A. and the Pacific North-West, including, of course, British Columbia, since it is said that "Victoria is more English than England itself," and these are the regions to which my remarks apply.

Even in these regions, as I have indicated, land is plentiful, and this fact has engendered a mental attitude to the soil which is quite foreign to the regard in which it is held by the European farmer. From the earliest days of large-scale settlement in America, which, it must be remembered, were less than 300 years ago, farmers have been accustomed to being able to pack up and move on to undeveloped virgin land. Consequently, there was apparently little need for them to conserve fertility and to ensure that the productivity of the soil was unimpaired when the farm was handed on to their children. Today there are no more large stretches which can easily be opened up, and any untouched areas require extensive irrigation or drainage before they can be farmed. This disregard for the principles of good husbandry, coupled with the intensity with which the rain beats down and washes away soil, is causing terrible soil erosion and is taking an alarming toll of the topsoil of the country. The soft, frequent showers we have in Britain may add to the trials of farming, but they spare us the scourge of soil erosion. Extensive educational campaigns, like those of the U.S. Soil Conservation Service, and large sums of money are being expended to change this type of outlook and instill in the minds of farmers the idea that if the soil is treated properly it will pay good dividends in the long run. I think that we in Britain can rightly be proud of our stewardship of the soil of our island, but the experience of America is a salutary reminder of the dangers of widespread soil exploitation if one is ever needed.

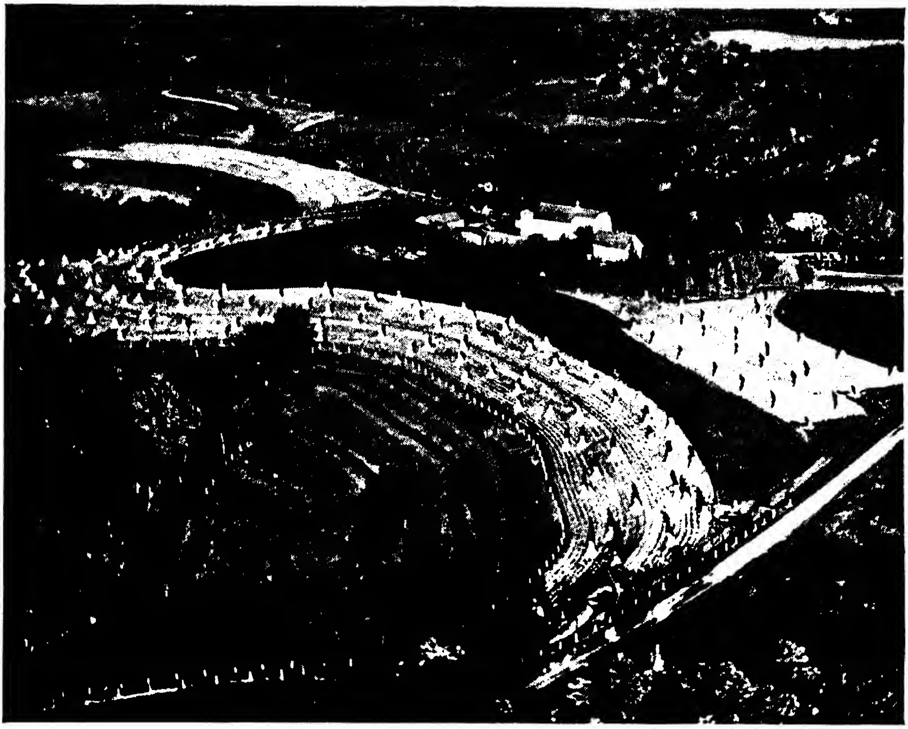
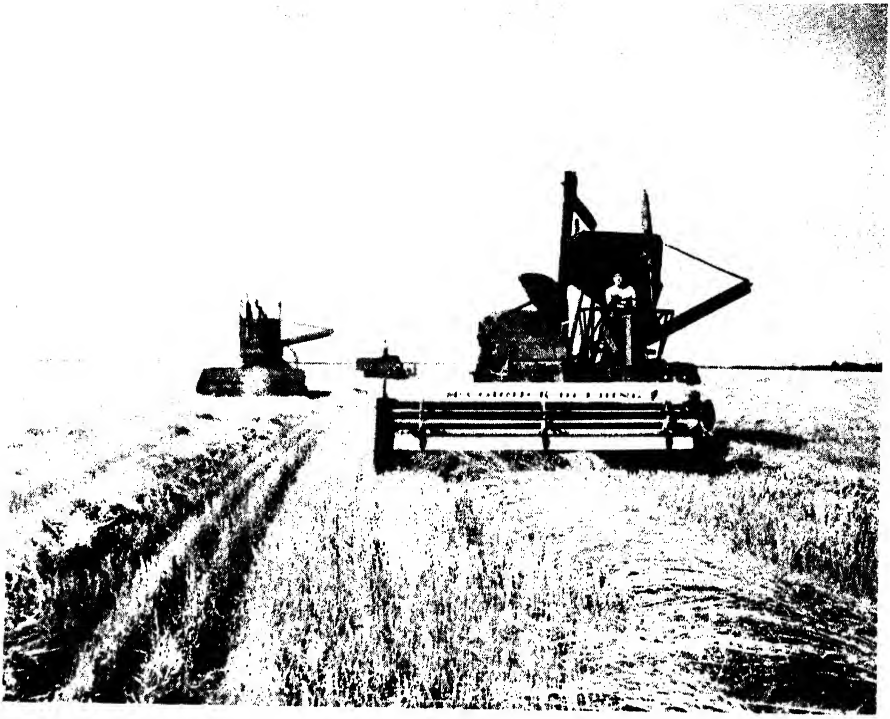


Photo: U.S.D.A. Soil Conservation Se.

Terrace cropping at La Crosse, Wisconsin. Bands of close-growing grasses between the grain crops retard water run-off and hold the soil. Pasture and woodland occupy land unfit for cultivation

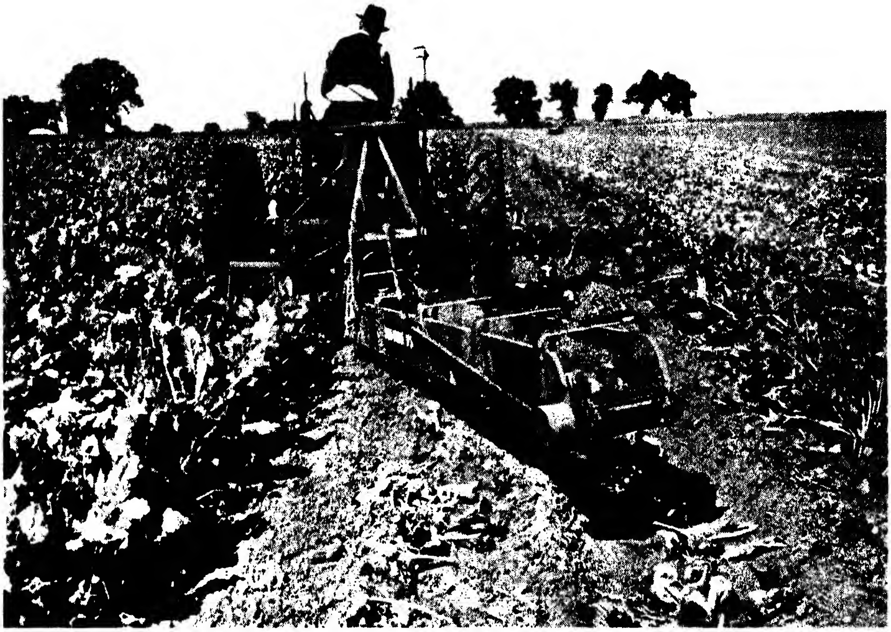
Photo: U.S.D.A. Extension Servic

Trough-feeding on the Louis Dinkley farm, Nebraska.



Harvesting wheat in tandem with 12-ft. machines in N. Dakota.

Using a field chopper on a maize crop near Montgomery City.

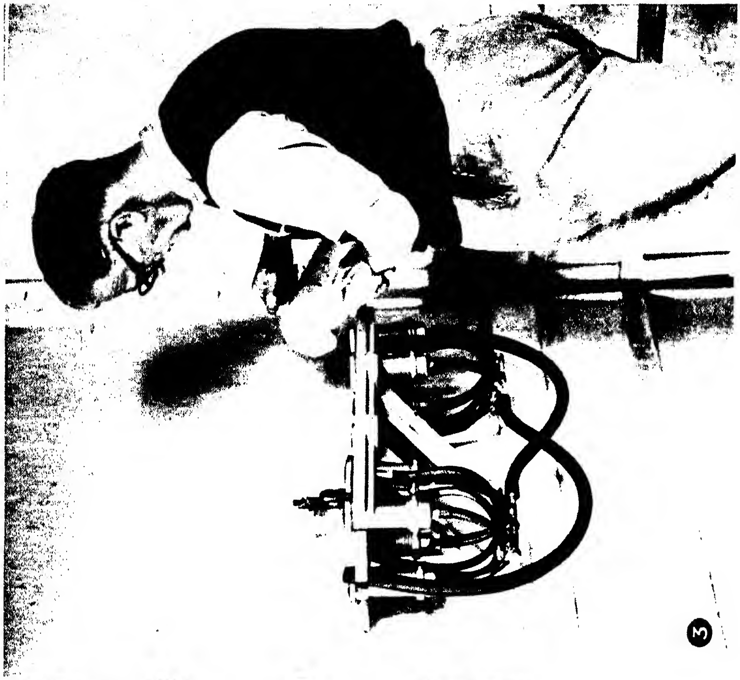


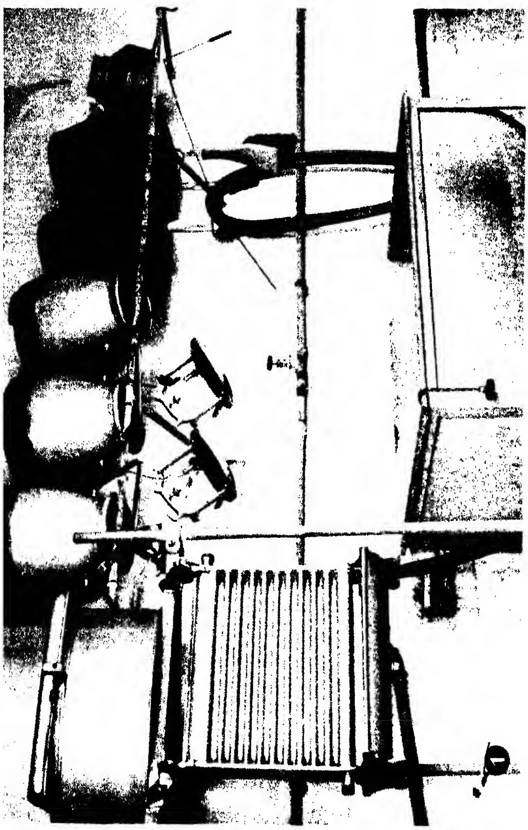
Beet harvesting with combine topper-lifter. Elevators are windrowing the beets and tops.

Photos: U.S.D.A. Extension Service

A potato-loader in use. The hoop is placed over the barrel, which is lifted hydraulically on to the truck.

APPROVED HYPOCHLORITES IN MILK PRODUCTION (See pp. 304-9)





Photos: N.I.R.D. Shinfield

1. Utensil rack providing good drainage. *(Photograph by courtesy of Mr. J. Matthews, Frith Farm, Wolverton, Hants)*
2. The inside of a milk tube, showing milk residues.
3. Filling milking machine clusters with wet-storage solution. *(Photograph by courtesy of Mr. C. E. S. Gillett, Hall Farm, Godington, Oxon)*

Ready Acceptance of New Ideas The North American farmer has always had plenty of elbow room and been able to take risks with his land. He has not been surrounded by long tradition. These and other influences have developed a farmer who is, by and large, an opportunist willing to take risks to achieve a quick financial return. This return is often judged by short-term standards without regard to possible hidden long-term effects.

The work of the advisory officer is in many ways easier in North America than in the United Kingdom, for farmers are often eager to try new ideas, and in many cases they run ahead of the scientist and the advisory husbandry experts. In the past few years there have been a number of examples of the possible dangers which may arise from this enthusiasm. The market has been flooded with new chemicals, and farmers of all types have been bombarded with high-pressure commercial advertising in the press, on the wireless, and at meetings. The result has been that in some instances they have tried to walk before they could crawl—and then, inevitably, tumbled. Hormone weed-killers have been used ill-advisedly and have harmed the crop being treated, or the spray or dust has been allowed to drift on to adjoining susceptible crops. DDT has been sprayed on everything that a bug might attack, with little thought of possible dangers due to a build up of the chemical in the soil, or of the rise of new insect pests following destruction of their predators. Thus we have the rather unusual situation of advisory workers being forced to issue repeated general warnings to farmers to go slowly and allow the experiment stations more time to evaluate the new materials and to formulate sound systems of application. I think that if we could hit the happy medium and produce a "hybrid" between the outlook of the British farmer and his American counterpart, real progress could be speeded up in both countries and the lot of advisory officers would be much happier. Nevertheless, we in Britain can profit by some of the results achieved in America from the vast amount of experimentation which is carried out at the research stations and on the ordinary commercial farms. A number of developments will be mentioned later, but first it is necessary to discuss some of the other important basic factors shaping farming methods in Canada and the U.S.A.

Scarcity of Labour In the areas under consideration hired farm workers have always been extremely scarce, and at all times a very large part of the manual work on the farms has been done by the farmer himself and his family. Therefore, labour-saving devices have always been eagerly sought and widely used when available, even though their economic return in terms of dollars and cents was doubtful. If some new tool or other saved some of the work in an operation or made their job more congenial, farmers would not look too critically at its cost, but rather measured its worth in terms of the saving in personal toil and discomfort. The general scarcity of labour over a long period has forced farmers to stress output per man—very often at the expense of good husbandry and high yields—whereas with our limited land area, output per acre is more important. The American farmer is willing to sacrifice something in yield by adapting his cropping practices to fit the machine, whereas our much more intensive system makes the task of the agricultural engineer more difficult because we want machines produced to fit the crop. It should be noted, however, that the need to cover capital costs and depreciation, especially of complex machines, is tending to intensify land use.

Mechanization is also promoted by the climate of much of this area. Little or no work can be done on the land during the long winters, and if

grazing purposes. Incidentally, it is worth noting that there is a considerable difference of opinion as to the advisability of sowing a grass along with lucerne. I think that if there is any doubt as to the certainty of obtaining a good stand of lucerne, a moderate amount of grass should be sown not only to give greater production, but also to keep the ground covered and prevent the rapid influx of weeds.

The American farmer learned his silage-making with maize, which is a relatively foolproof crop to handle, and the switch-over to grass silage has been relatively easy in comparison with the task of the British farmer starting from scratch with grass. Grass silage is increasing in popularity and, although maize for silage can be grown very successfully over most of the area, grass, which protects the land from erosion, is taking its place in many districts. There are two schools of thought in America on the use of molasses or other carbohydrate material when ensiling grass. Recent work by the U.S. Department of Agriculture has shown that if the crop is allowed to wilt in the windrow until the moisture content falls to about 65-70 per cent, excellent silage can be made without any additions. The other school, however, while not criticizing the soundness of this practice under skilled supervision, is of the opinion that it is difficult for the ordinary farmer to judge the moisture content accurately, especially in broken weather. Its recommendation is that as a safety measure ample molasses—at least 50 lb. per ton—should be added to the material as it is put into the silo, even if some wilting has taken place. The reduction of weight achieved by wilting is not of much importance under a system of mechanized handling.

An appreciable number of farmers, especially dairy farmers, are installing portable overhead irrigation systems for pastures, and claim that the returns fully justify the cost. On the Pacific coast, even though the annual rainfall may approach 100 inches, dairymen consider that it is worth investing in a system solely for their dairy pastures to combat the regular drought period during July and August when pastures burn up badly. In the eastern states a serious drought is not an annual occurrence, but every three years or so pastures are badly hit. There the tendency is rather to use equipment which is already available for market-garden crops, since the economics of a system solely for pasture are at the moment rather doubtful. It appears, however, that where water is available overhead irrigation, even of pastures, might be a profitable venture on farms in eastern England.

Livestock Production The striking results achieved in the U.S.A. in the eradication of tuberculosis among dairy cattle during the past thirty years provide encouragement to everyone concerned with the eradication programme in the United Kingdom. The campaign started in 1917, and by 1940 all the 3,000 odd counties had reached the accredited standard, i.e., less than 0.5 per cent reactors among the dairy and breeding cattle. This has been achieved by a test and slaughter policy combined with compensation payment for reactors. As at home, abortion and mastitis are the two great problems in dairy farming; the methods employed in the control programmes are very similar to our own and do not call for mention here. Calfhood vaccination of all animals is favoured in many instances as a good insurance policy, even if no reactors are present. In the case of mastitis the great importance of careful management of the cattle to avoid injury or chills continues to be stressed, although the use of penicillin has greatly increased the prospects of recovery of infected animals.

In the field of livestock-breeding the work of the experiment stations on the value of the proven dairy bull is having a profound influence on dairy cattle-breeding, and the rapid expansion of artificial insemination facilitates

the use of these good bulls. (It is estimated that close on 10 per cent of the dairy cows are artificially inseminated.) Efforts are now being made to obtain some measure of the breeding value of beef bulls similar to the milk yields of the daughters of a dairy bull.

The U.S. Department of Agriculture is also carrying on a dairy cattle-breeding experiment where animals of four breeds (Guernsey, Jersey, Holstein (Friesian), and Red Dane) are crossed in a regular system. It has created much interest and aroused some controversy. It is claimed that by crossing animals of two different breeds some hybrid vigour is obtained and that, provided good bulls are used, interbreed crossing on a large scale will result in a general improvement in milk production. Final judgment on this experiment and on the possible lessons to be learned from it ought to be reserved until more research has been carried out.

Polled strains are now well established in the normally horned Hereford, Shorthorn (both beef and dairy types), Ayrshire, and Holstein breeds. Although the polled animals are not at present equal to the horned ones in quality, the gap is being reduced and British breeders, especially of beef cattle, might well consider developing polled strains. Polled beef animals have a material advantage for transport and also on the ranges, where dehorning is difficult and frequently leads to losses due to screw worm and other infections. Overseas breeders will undoubtedly select a good polled animal in preference to a horned one whenever the quality of the former is improved sufficiently. In the case of dairy cattle, dehorning is easier, since they can be treated in calfhood without danger.

Machinery and Equipment The differences in the degree of mechanization of cultivations on the farms of Britain and America are, I think, frequently exaggerated, and due consideration is not given to the differences in soil, climate, and lay-out of holdings. However, when it comes to the actual handling of the crops themselves, especially in and around buildings, we can learn much from American practices.

The tractor in America is coming to be regarded as a sort of power-driven framework to which the farmer can affix a large number of different pieces of equipment and from which he does most of his farming. Sprayers, dusters, planters and the like are being designed more and more as integral parts of the tractor for ease of control and provision of power. The recently-introduced hydraulic cylinder connected to the tractor by flexible hoses for the control of implements such as ploughs and discs really gives them most of the advantages of attached equipment. The tractor is no longer regarded primarily as a powerful horse to pull pieces of equipment, although it is equally suitable for this type of work. One sees very few of the four-wheeled, fixed-track width type of tractor which were, and still are to a certain extent, so popular in the United Kingdom. Developments in metallurgy enable the weight to be cut down, and the tractor is becoming more and more of an open skeleton with the toolbar fitted in front of the driver. These improvements in the driver's vision, combined with more widely-spaced rows, enable cultivations to be carried out at higher speeds.

Agricultural engineers are quite prepared to declare that the next stage in the mechanization of a crop lies with plant breeders and others who must make the crop fit the machine. I have mentioned how this attitude is affecting the development of sugar beet for easy seeding, cleaning, and harvesting. Something similar is happening with potatoes, where a thicker skinned tuber, which will not bruise so easily during mechanical harvesting, is being demanded and will probably be forthcoming in due course. Lucerne

breeders are hopeful that it may be possible to develop strains which will retain their leaves better during haymaking and thus avoid a serious loss of rich feed. The farm machinery manufacturers also rely heavily on new developments thought out by farmers who build up the machine or new part in the well-equipped workshops, which are a common feature on farms. California is the source of many contraptions which look weird and impractical at first sight, but some soon prove their worth. Many of the ideas pass eastward across the 3,000 miles of the continent and are modified and adapted to suit local needs. Machines for knocking nuts off trees, pneumatically-operated pruning platforms mounted on tractors, high speed hay-rakes consisting of a number of spiked wheels are a few of the gadgets we have noticed in recent months. Few are likely to be adaptable to our conditions, but the ideas behind them may possibly have application and should be worth following up.

The mechanization of the grass silage crop is now well advanced, largely because it has been possible to adapt much of the maize-handling machinery. On some large farms the grass is never handled until it is forked into the manger; a forage chopper delivers it into a wagon, which is unloaded mechanically into the hopper of the silo blower. This in turn discharges the grass into the tower silo, which incidentally has the advantage that no one needs to go outside to collect the silage in the severe winter conditions, as in the case of pit silos. Mechanical silo unloaders which discharge the silage into the feeding cart beneath the chute are now on the market. Farmers frequently share their silage-making equipment so that the capital cost which would be high for one farmer is brought down to a reasonable level.

The severe winters force farmers to provide housing space for all their animals, including sheep, and the typical two-storey barn with its hay loft is a characteristic feature of the landscape. There is, however, a distinct swing away from the highly insulated barn with all its ventilation and condensation troubles towards a single-storey, more airy cowshed. The practice of keeping cattle in littered pens and bringing them to a combine milker for washing and milking is spreading fairly steadily. Provided a farmer has sufficient straw and dehorns his cattle, I think this system has many advantages, since labour is reduced and the health of the cows improved. I believe that we should not try to follow the system of storing fodder in a dual-purpose, two-storey shed, owing to the cost of construction and fire risks, but should continue to develop simpler single-storey sheds designed for a particular purpose and laid out in a functional manner.

It is in the use of electrical equipment in and around buildings that we lag further behind. It is estimated that, notwithstanding the distances involved, 70 per cent of American farms have mains electricity, and in some of the more densely populated states like California and New York, the proportion is much higher—95 and 94 per cent respectively. Power is in general relatively cheap, and farmers are utilizing it so extensively that distribution lines and transformers are unable to carry the load; many farmers have, therefore, to limit the amount of equipment they can install. In spite of the severe winter storms which result in breakdowns, farmers are still prepared to use electricity for such work as milking, water-pumping and refrigeration, keeping a petrol engine in reserve. I think we can learn something from the American methods of distributing and using electricity in rural areas and, while I think that our safety requirements should not be lowered, some simplification and standardization of equipment would help to reduce costs.

Education and Research In each state, agricultural research, education, and advisory work largely centre in the Land Grant College, and there is a tendency for one man, the Dean, to be placed in charge of all three branches with an assistant for each one. The advantages claimed for this close integration (which resembles the Scottish system) are that it brings research workers into contact with the advisory and teaching staffs, and frequently one man may do more than one type of work. Distractions like calls on research workers for advisory duties and demands by the state legislature or local farm organizations for quick research results are not incapable of control. A State College which frequently acts for an area as large as the United Kingdom is often much better known to the farmers it serves than similar institutions here. Staff members speak at meetings of all types throughout the State, its publications are widely distributed, thousands of farmers and their families attend functions at the college, and many colleages have their own broadcasting station ; all these keep farmers in touch with "their" college.

In the United States, the Extension Service (Advisory Service) has a much wider field of activity than at home, and its work is perhaps better described by the term "rural welfare". Home economics (rural domestic economy), work with boys' and girls' clubs, and advisory work in agricultural economics all come within its jurisdiction, but it has now no executive functions. This apparent advantage is, however, now largely offset by the fact that advice given by the Extension Service may conflict with that of executive agencies like the Soil Conservation Service and the Farmers' Home Administration. The general structure of the Extension Service is not essentially different from the National Agricultural Advisory Service except that, as already mentioned, the headquarters in each state are normally located at the agricultural college. The techniques used in the advisory work differ somewhat from those we use in the United Kingdom ; they have been evolved to suit the rather different temperament of the American farmer. The community spirit is generally very strong, and the advisory officers find that they can achieve good results and can reach a larger audience by sponsoring one or more projects. For example, the county agent and his advisory committee may decide that grass silage should be encouraged. Local groups are formed to discuss and practise the new idea, engendering a sense of competition among the participants. This system achieves a considerable measure of success, but too often it tends to undue emphasis on one particular operation, e.g., dairying, rather than the promotion of a generally balanced upgrading of the farm as a whole. Many extension workers are now turning more to what is termed "Farm and Home Planning" to avoid such specialized approaches. This usually involves the preparation of a comprehensive cropping and stocking plan for the farm and may mean a complete change in the whole set-up. I do not think it would be suitable under British conditions, but the fact that the farmer's wife, and often the whole family, is concerned with the preparation of the programme is a lesson which has application here.

Canadians and Americans make much wider use of broadcasting as a means of getting ideas across to farmers. Programmes are much more local in character, and frequently the County Agent (Executive Officer) has a weekly or even daily item. The informal and spontaneous nature of the programmes increases the appeal to rural audiences, and surveys have shown that a large proportion of farm families listen to them regularly.

I am deeply indebted to Mr. A. N. Duckham, Agricultural Counsellor, British Embassy, Washington, for his help and guidance in the preparation of this article.

A STUDY OF THE BRITISH POULTRY INDUSTRY

R. Coles

Ministry of Agriculture and Fisheries

ONE of the most remarkable features of British post-war agriculture has been the recovery of the poultry population. This rapid revival, despite limited supplies of rationed food, is generally attributed to the much wider interest of the general farmer in poultry-keeping based on the more extensive use of home-grown foods. An inspection of war-time and post-war agricultural returns supports this view. Table 1 shows the poultry population during recent years.

Table 1

Numbers of Fowl on Agricultural Holdings in June

(millions)

Year	England and Wales		Scotland		Northern Ireland		United Kingdom	
	Adult Birds	Total	Adult Birds	Total	Adult Birds	Total	Adult Birds	Total
Average 1936–1939*	24.0	54.0	3.6	7.5	4.6	9.3	32.1	70.7
1943	13.3	26.5	2.9	5.8	7.1	14.1	23.3	46.4
1946	16.0	36.2	3.5	7.2	8.9	18.3	28.4	61.7
1948	19.6	47.9	4.1	8.7	10.7	22.6	34.4	79.2

*As a result of war-time controls, many holdings which had previously escaped enumeration were recorded in 1941. It is estimated that between three and four million birds should be added to the June totals prior to 1941 to make them reasonably comparable with the totals for subsequent years.

England and Wales show the greatest fall in numbers by the close of the war, and these two countries are the only ones in the United Kingdom which have failed to reach and exceed their pre-war level. The steady growth of the poultry population on the small farms of Northern Ireland throughout the past decade is very significant. This slower rate of recovery in England and Wales is held, with every justification, to be due to the greater measure of specialization in poultry-keeping which existed there before the war. This specialist activity was often carried on without any other agricultural enterprise, and, in fact, many of these poultry specialists had no available land on their smallholdings for developments unconnected with poultry-keeping. With partial or complete dependence on purchased food, these pure specialists suffered extensively when the rationing system was imposed during, and maintained after, the war. The continued rationing of livestock feedingstuffs has greatly limited their recovery, and since the number of farmers solely dependent on poultry-keeping was far greater in England than elsewhere, England has had a greater handicap in her endeavours to reach pre-war status.

Throughout the war it was the policy of the Government to maintain adequate numbers of breeding birds, and a higher level of rations was made available to approved breeders. In consequence, many of the specialist poultry-keepers concentrated their attention on breeding flocks, and profited by the large demand for breeding stock from domestic poultry-keepers, whose numbers increased rapidly during the war period.

The change in emphasis in poultry-keeping to a greater dependence on the general farmer as a supplier of table eggs is commonly regarded as a

desirable tendency in view of the uncertainty about future supplies of imported feedingstuffs. The purpose of this article is to examine other aspects of the present structure and the present trend of Britain's poultry industry.

Conditions before the War . . . Before dismissing the pre-war poultry specialist it would perhaps be as well to stress the fact that he was a past master in the art of managing his flocks to produce eggs. Not only did the annual production of his birds reach a high level—180 was usually regarded by the successful specialist as a minimum—but he also ensured that a high proportion of the annual yield was achieved during the autumn/winter period, when prices were highest because of a prevailing shortage of supplies from other home or overseas, sources. The statement that the United Kingdom has a greater number of fowl than in pre-war days is often received with some scepticism, because of the fact that market supplies of home-produced eggs are generally lower than before the war, particularly in the winter period. The effect on total production of the decline in the numbers of the pure poultry specialist must not be overlooked. The average hen-housed egg production per adult bird in England and Wales in pre-war days was estimated by the Reorganization Commission for England and Wales* to be over 120 per year. This figure exceeds that claimed by either Canada or the U.S.A. in 1946.† Today the average of the country's adult stock is generally considered to be substantially below that figure—indeed, a figure about 100 has been suggested—but it is difficult to form a reliable estimate, and this figure is probably subject to a margin of error which cannot at present be determined accurately.

Production figures relating to such a widely-scattered industry are bound to be impossible to prove. The important point is the assumption of a decline in the national production figure. A partial decline is usually attributed to the poorer quality of purchased food ; it has not been contended that home-grown foods make good any such deficiency. Another factor is the natural tendency to keep more birds than the supply of feedingstuffs properly warrants. Apart from the consideration of change in the nature of the suppliers of table eggs, changes in the supply of eggs are equally important. Reference has already been made to the attempts of the specialist to achieve high production during the time of shortage. In Fig. 1 the throughput, price curve and income realized from the sale of home-produced eggs is shown. The figures relate to the number of eggs packed in 1936 under the National Mark and to the prices fixed by N.M. Egg Central. It will be noted that in the six months February-July inclusive 58 per cent of the total number of eggs packed reached the market ; in the autumn/winter months, 42 per cent were marketed. The price curve inversely reflected this production curve, the average price during the month of lowest prices being 8½d. per dozen, and that during the highest, 2s. 3d. The income from the sale of these eggs indicates that the six winter months were responsible for 53 per cent of the total annual income, and the summer six months 47 per cent. The period of the smaller supply was responsible for the larger part of the annual income. It will be recalled that the specialist of that period aimed at achieving a high production rate during the period of higher prices.

**Eggs and Poultry. Report of the Reorganization Commission for England and Wales*, published by H.M. Stationery Office (1935). Price 1s. (1s. 3d. by post).

†*Development of the Poultry Industry in North America* (*Agriculture Overseas Report No.* 6), published by H.M. Stationery Office (1947). Price 1s. 6d. (1s. 8d. by post).

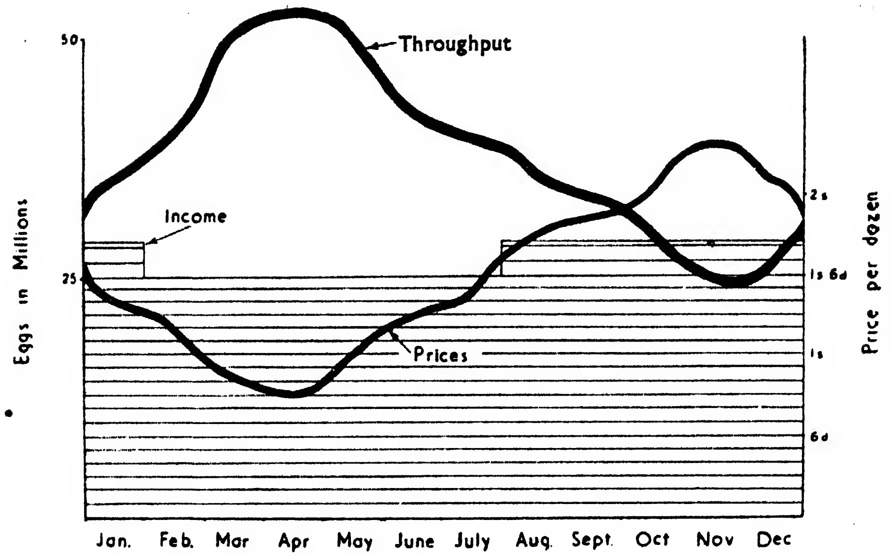


Fig. 1. Throughput, prices and income of National Mark eggs in 1936.

. . . and after the War These figures make an interesting comparison with those of the post-war period. It must be remembered that until April, 1949, egg prices had for some years been fixed at a constant figure without reference to season. Regarding the deliveries during 1946 as those of a normal post-war year (absence of unusual weather conditions and effects of special bonuses), the income (based on a flat producer price of 4s. per dozen)* and output trends shown in Fig. 2 present an extreme exaggeration of some of the tendencies observed in 1936, and a reversal of others. The figures relate to the number of eggs reaching Ministry of Food packing stations. The spring/summer period is now responsible for 70 per cent of the annual throughput and, with a flat price, also for 70 per cent of the annual income. The six winter months have only 30 per cent of the annual throughput of packing stations and are responsible for the same proportion of the annual income. *The period of greatest income is now associated with the period of highest production.*

It is interesting to learn that if the pre-war income difference were required on present-day output (of eggs reaching packing stations), the spring figure would need to drop to 2s. 10d. per dozen and the autumn figure rise to over 7s. The recently-announced seasonal prices for 1949-50 range from 3s. 9d. per dozen in the spring to not less than 5s. in the autumn. There can be no doubt that one of the reasons for the falling-off of autumn production has been the lack of incentive during a period when a constant price has been in force. The dominance of the spring production is disturbing ; a detailed examination of the size and distribution of existing poultry flocks suggests that the lack of a seasonal price is not the only reason for its existence.

*The " flat " price has been, in fact, altered frequently to meet increased costs since its introduction in 1942, but for the purpose of illustration the 4s. per dozen price operating in 1947-49 has been used in the diagram. The actual price in 1946 (year average) was 3s. 4¾d. per dozen.

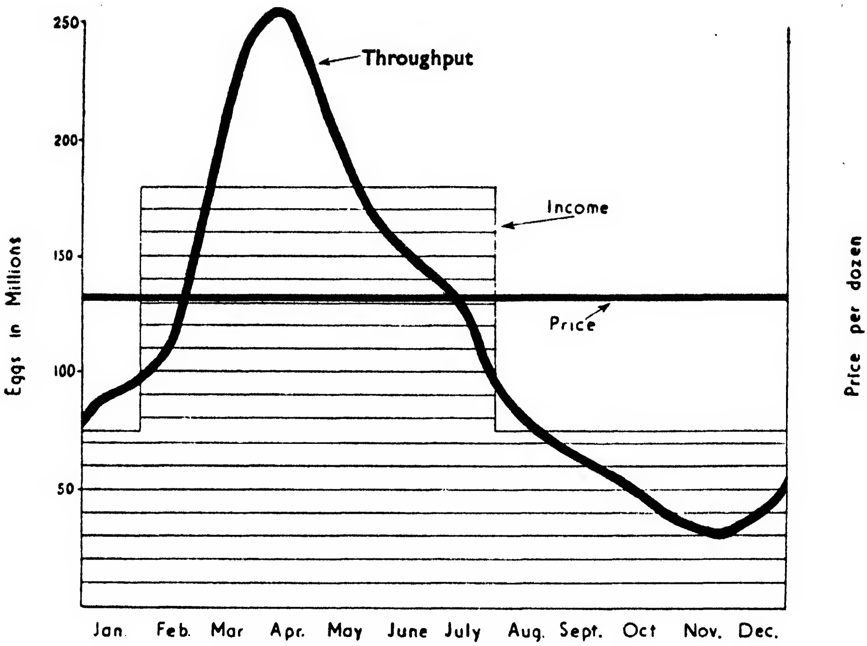


Fig. 2. Throughput and income (calculated on a constant price) of eggs handled by Ministry of Food packing stations in 1946.

Of the 370,508 holdings in England and Wales returned in June, 1948, 293,915 were shown to carry adult fowl. Table 2 shows the percentage of the holdings with adult fowl according to flock size.

Table 2

No. of Adult Birds	Percentage of Holdings	
Under 50	66.15	85.53
50–100	19.38	
101–200	9.71	13.59
201–500	3.88	
501–1,000	0.67	0.88
Over 1,000	0.21	

It is possible to assess the number of adult birds maintained by these three main groups and to make a reasonable approximation of the percentage of the total eggs supplied to the market by the three groups (see Table 3). The total of adult fowls returned in June, 1948, was nearly 20 million.

Table 3

Percentage of Holdings	No. of Adult Birds (*millions*)	Percentage of Market Eggs Supplied
85.53	9.5	35
13.59	8.0	50
0.88	2.5	15

The proportion of market eggs supplied is based on the assumption that with flocks of under 100 birds a fairly high proportion is used for home consumption, and that production per bird is generally lower in the smaller

flocks—a point which will be dealt with later. It will be argued that the converse also applies.

The most interesting features about these figures are that out of every 100 holdings carrying adult poultry 85 have flocks with under 100 adult birds, and that only one out of every 100 flocks is of a size where specialized management is an economic and feasible proposition. This does not, of course, imply that flocks of less than 500 birds are necessarily badly managed, but it is evident that in many of such flocks there is greater scope for improved efficiency. An inspection of pre-war figures indicates that before 1939 fewer farms carried poultry, and, as is expected, a larger percentage of farms came in the group with 500 birds or more. The precise figures are that 261,466 holdings carried poultry in 1939 as against 293,915 in 1948, but 4,794 farms carried more than 500 adult birds in June, 1939, as opposed to 2,562 farms with more than 500 adult birds in June, 1948. Many of these larger poultry units are concerned with poultry-breeding.

The Small Farmer's Contribution There can be no doubt, therefore, that the overwhelming bulk of our poultry is carried by the general farm, including in this term the large number of holdings of under 20 acres, which in many cases provide only a part-time activity of the occupier. (These small farm flocks must not be confused with those of domestic poultry-keepers, with whom this article is not concerned.) At the same time, it must be appreciated that poultry is, for the most part, carried by the general farm in very small flocks and *that these small flocks are responsible for the bulk of the eggs produced in this country today*.

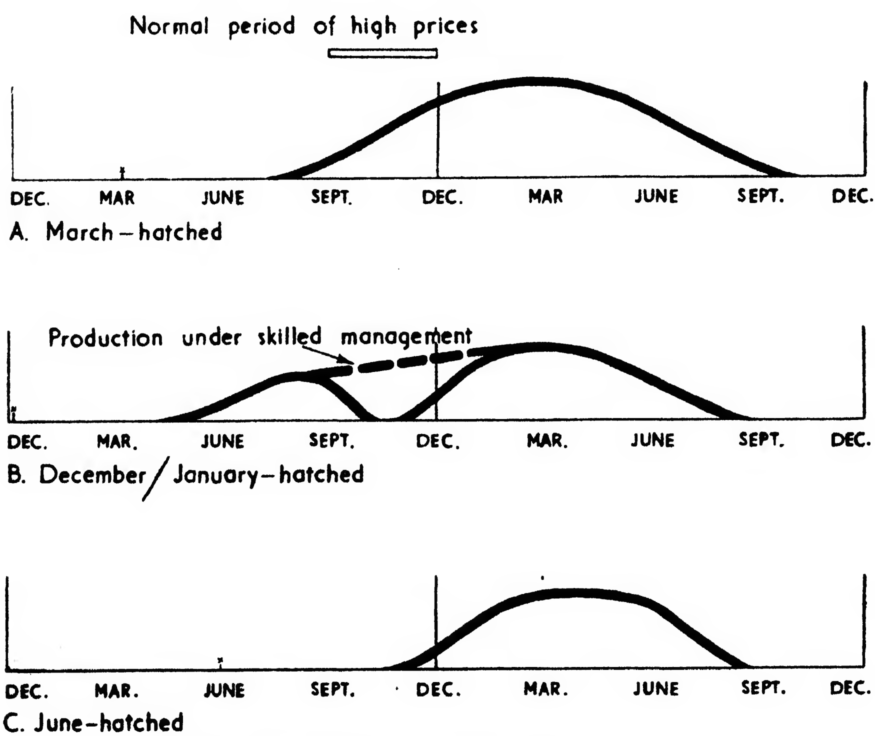


Fig. 3. Production trends with different hatching dates.

If this contention is accepted—and no other conclusion seems possible—then the general farmer (as defined above) is largely responsible for the present emphasis on spring production and, from his increased active participation in the poultry industry, the reduced assumed annual average egg production per bird has in part resulted. The diagrams in Fig. 3 indicate the way in which seasonal production varies according to the date of chick hatching. Of particular interest is diagram 3B. In the case of early hatched birds (December/January) the probability of the birds going out of production in the late autumn depends in large part on the skill and management of the poultry-keeper. The specialist expects to keep his birds in production during that period by a high protein diet, by intensive or semi-intensive housing, and by lights. With a small flock the farmer may not consider this expenditure of labour (and often money on equipment) worth while, and in recent years there has been no financial incentive for him to do so. Recruits to the poultry industry during the greater part of the last decade have had no experience of those methods.

The Future of the Industry The re-emergence of seasonal prices gives rise to the thought that the British poultry industry now founded on the general farm may be badly balanced. This is a matter which demands instant and serious consideration. If every adult female bird produced 100 eggs per year the income from eggs and carcasses per year at controlled prices would be very little below £75 millions—a very substantial part of our agricultural income. A substantial decline in *annual* income or a slump in poultry-keeping would be a serious blow to British agriculture. The existence of a marked spring production, coupled with a return to seasonal prices, makes the poultry industry particularly liable to a decline in annual income.

So long as egg prices were constant throughout the year and prices of feedingstuffs were stabilized at about the 1940 level, the 100 bird-flock, producing eggs mainly in the spring and utilizing a fair proportion of home-grown feed, was a profitable proposition, bearing in mind that as a rule only unpaid family labour was employed and that some income also accrued from the sale of birds for the table. On the credit side also is the value of the poultry manure to the farm where poultry is integrated into the general farm economy.

The return of seasonal prices has resulted in a reduction in spring prices, and has coincided with an increase in food costs.

Unless there is a change in production practice, or a marked improvement in egg yield per hen, there is a decided risk that the poultry-keeper who is largely dependent on purchased feedingstuffs will find his profits disappearing. Those poultry-keepers using a considerable proportion of food grown on the farm will be in a more favourable position so far as food costs are concerned.

Poultry farmers are no doubt bearing in mind that when the average price of 4s. 1d. per dozen for 1949-50 was announced, it was stated that, other things being equal, the price for 1950-51 was likely to be lower than this (subject, of course, to the guaranteed minimum of 3s. 4d.). Clearly the British poultry industry has reached a rather critical stage in its development. Should the majority of the producers of eggs in this country estimate their future profits by reference to their present seasonal returns, the prospect would be discouraging, and the industry would risk a decline. It is as well to face these unpalatable facts and seek a remedy.

It seems obvious that we cannot safely expect a plentiful supply of cheap animal feedingstuffs from overseas in the foreseeable future. That assumption

would appear to dim the hopes of the specialist egg-producer for an early return to his pre-war system of poultry-keeping, with its high egg production and relatively high winter production. To increase the general farmers' flocks without any change in method would be to make the industry more vulnerable still, and create a demand for more farm labour for a section of agriculture where efficient production is open to doubt. There seem to be two systems for the general farmer to follow which will lift the bulk of the poultry industry of this country into the sphere of both profit and efficiency.

The first need appears to be an insistence by the farmer who follows some kind of field management on early spring-hatched chicken. In this way he should see a high production at the period of high prices. The "factory system" practised in the U.S.A. of purchasing new laying stock each year has much to recommend it, since it allows the high pullet year production (compared with that of the hen), and the carcasses of the birds at the close of their laying year give an additional profit. The second recommendation is that a return to semi-intensive or intensive methods should be considered—but by the general farmer who can grow most of the food himself. The choice of cage batteries or built-up litter in converted barns is a matter to be dictated by individual circumstances, but both methods result in high total egg production with a minimum of labour per bird, and are associated with high winter production. Both achievements are now vital to the well-being and continuance of the poultry industry of this country.

Whichever method is adopted, it is essential that the producer should strive to attain a high degree of self-sufficiency in feedingstuffs, which will lower feeding costs, and that the poultry unit should be properly integrated into the economy of the farm so that full advantage is taken of manurial effects. In the latter respect the merits of the folding system should not be ignored where the less intensive system of poultry-keeping is followed. It is equally important that close attention should be paid to reducing unit costs of production so that profitability will not be impaired, even if prices per dozen have to come down.

Preservation of eggs by improved methods may be a help to the industry. Oil dipping appears to promise well; the success of the system depends on both the good results of the method and the acceptance of the eggs by the consuming public as equal to, or little below, fresh eggs in quality. Even so, since profitable storage depends on cheap purchase during the flush period, the dangers threatening the industry are not obviated.

OFFICIALLY APPROVED INSECTICIDES AND FUNGICIDES

Since the date of the list published in the April, 1949, issue of *Agriculture* (p. 44) the following names of proprietary products have been added to the approved list under the Ministry's approval scheme.

Miscible Tar Oil Winter Washes:

Pest Control Tar Oil Miscible Winter Wash	Pest Control Ltd.	**D 312**
Sanatol Tar Oil Winter Wash	Sadler & Co. Ltd.	**D 336**

OFFICIALLY APPROVED INSECTICIDES AND FUNGICIDES

Derris and Lonchocarpus Insecticides to be used as Sprays:

Buggé's Concentrated Liquid Derris	Buggé's Insecticides Ltd.	**H 319**
ITP Liquid Derris	International Toxin Products Ltd.	**H 101**
Kilsect Liquid Insecticide	Pan Britannica Industries Ltd.	**H 281**

Copper Fungicides (exclusive of Seed Dressings) to be used as Dusts:

Blitox Dust Copper Fungicide	Pest Control Ltd.	**J 327**
Buggé's Copper Lime Dust	Buggé's Insecticides Ltd.	**J 334**

Nicotine Insecticides to be used as Dusts:

Buggé's Nicotine Dust 4%	Buggé's Insecticides Ltd.	**O 335**

Nicotine Insecticides to be used as Sprays:

Boots Nicotine Dust	Boots Pure Drug Co. Ltd.	**O 170**
PBI Nicotine Wash	Pan Britannica Industries Ltd.	**P 283**

Stock Emulsion Petroleum Oil Summer Washes for Orchard Use:

Buggé's Summer BIL Petroleum Emulsion	Buggé's Insecticides Ltd.	**T 333**

Sulphur Fungicides to be used as Dusts:

Boots Green Sulphur Dust	Boots Pure Drug Co. Ltd.	**AA 307**

Sulphur Fungicides to be used as Sprays:

Boots Sulphur Spray	Boots Pure Drug Co. Ltd.	**AB 309**

DDT Insecticides to be used as Dusts:

Flebetox	Pest Control Ltd.	**AD 329**

DDT Insecticides to be used as Sprays:

BIL DDT Wettable Powder 20%	Buggé's Insecticides Ltd.	**AE 318**
PBI 10% DDT Emulsion	Pan Britannica Industries Ltd.	**AE 295**

Formaldehyde:

Boots Formaldehyde	Boots Pure Drug Co. Ltd.	**AV 302**

DNC-Petroleum Oil Winter Washes:

Pest Control 1.3% DNC Petroleum Standard Winter Wash	Pest Control Ltd.	**AZ 314**
Pest Control 2.2% DNC Petroleum Standard Winter Wash	Pest Control Ltd.	**AZ 315**
Shell Dytrol DNC Petroleum Winter Wash	Shell Chemicals Ltd.	**AZ 265**
Shell Universal DNC Petroleum Winter Wash	Shell Chemicals Ltd.	**AZ 265**

Calomel Dusts (4%):

Boots Calomel Dust	Boots Pure Drug Co. Ltd.	**BB 322**

Product B 26 *has been withdrawn from the list by the manufacturers.*

Ministry of Agriculture and Fisheries, Plant Pathology Laboratory, Harpenden, Herts. September, 1949.

FARMING AFFAIRS

Autumn-sown Mixtures for Spring Grazing and Silage

From the harvesting point of view, the year 1949 has been a memorable one. The ideal weather both for hay and corn enabled first-class material to be harvested for winter feeding, and the sight of one field after another cleared of corn so early and at such speed has given great satisfaction to the farmer.

This speed and smoothness of harvesting operations have afforded the farmer a breathing space to consider further opportunities not available in average years. There are vast areas of stubble land which will not be carrying any crops during the autumn, winter and spring months. Bearing in mind the seriousness of the country's food situation and the scarcity of feedingstuffs, every farmer should consider the possibilities of producing additional high protein food to supplement the excellent fodder available this year. In districts that have been fortunate in getting some rain, many farmers have already taken advantage of the very early harvest by ploughing up and sowing rape to provide food for cattle and sheep later in the year.

Excellent results have been obtained in certain counties during the last two years by ploughing up the stubbles as soon as the corn has been cleared and sowing cereals or a mixture of cereal-legume, with or without Italian ryegrass, thus providing high protein food for stock during late March and April. The mixtures used in these demonstration plots of one acre each were:

1.	Rye	1 cwt.	2.	Rye	1 cwt.
	Italian ryegrass	15 lb.		Vetch	56 lb.
3.	Rye	1 cwt.	4.	Rye	¾ cwt.
	Vetch	28 lb.		S.147 oats	¾ cwt.
	Italian ryegrass	10 lb.		Italian ryegrass	10 lb.
5.	S.147 oats	1 cwt.			
	Vetch	28 lb.			

An application of 3-4 cwt. of complete fertilizer per acre was made by the combine drill at the time of sowing, with a further dressing of nitrogen in the spring.

These crops were ready for grazing during the last week in March. The yields varied from 2½ to 3½ tons per acre at the beginning of the grazing period. The crops were growing vigorously at this time and during the six weeks the milking cows were on the plots. At one centre the first plot grazed provided a good crop for silage by the time the stock were grazing the fourth plot. The milking cows were allowed to graze the crops for periods ranging from half an hour to one hour after each milking.

At one centre thirty cows were on the plots (five acres) for six weeks from March 30. Then the hay was reduced by half and the concentrates by one-third. The quantity of milk increased by 20 gallons a day during the period. At another centre two acres provided grazings for ten cows from March 26 to May 5, with the exception of ten days' rest given to the plots in the middle of the period.

Four acres at another centre were first grazed by sheep and lambs, followed by dairy cows for a period of five weeks starting April 18. The yield of milk obtained during the time the cows were on the plots increased by 38 gallons per day.

The growing of these crops on autumn-cleared stubbles is not new—the sowing of small acreages of winter rye and vetch is an old practice on many farms. Early sowing, good manuring, and the use of a combine drill with a further dressing of nitrogen in the spring will result in the crops being ready for use much earlier than in the past.

AUTUMN-SOWN SILAGE MIXTURES. Advantage can also be taken of early cleared stubbles by sowing silage mixtures. The results of four demonstration plots sown in the autumn of 1948 are shown in the Table below :

Plot No.	Mixture *lb. per acre*	Green Matter *tons per acre*	Dry Matter *per cent*	Crude Protein *dry matter basis per cent*	Crude Protein per acre *lb.*
1.	80 winter oats 60 ,, beans 60 ,, vetch	18.5	17.00	19.78	1,338
2.	120 winter oats 60 ,, vetch	15.1	16.67	18.32	1,146
3.	120 winter rye 60 ,, vetch	12.7	25.67	15.17	1,108
4.	60 winter oats 60 ,, barley 60 ,, vetch	10.7	19.67	17.76	837

The above mixtures were sown on October 8 on land previously carrying a mixed corn crop. The land was in good heart, and at the time of sowing was dressed with 2 cwt. per acre of complete fertilizer. The crops were weighed at the time of cutting on May 14. Yields were heavy, with a high percentage of crude protein and total protein per acre. The value of these crops can be appreciated from the fact that green material at the time of cutting contained on an average the equivalent of 33 cwt. of linseed cake (of 30 per cent crude protein) per acre.

The crops made into silage and those grazed in the spring were followed by root crops, kale, rape, and/or reseeded without a nurse crop.

Anthrax Because of increased importations of feedingstuffs and fertilizers, anthrax is now more prevalent in this country than for the past five years. Stock-owners should report to the police any cases of sudden death among their animals (especially cattle) if there is any possibility that death was due to anthrax.

The onset of the disease is often sudden, and the period of illness may be so short that the animals may be found dead without signs of illness having been seen. Where death is less sudden, high temperature, shivering and twitching, harsh dry coat, fits, bright staring eyes, dejection, refusal of food, or marked or complete loss of milk may be noticeable. Occasionally there may be a small trickle of blood from the nostrils, or signs of blood in the dung of the ailing animal.

The blood of affected animals is full of germs. These germs are capable of living outside the animal in the ground or elsewhere for a very long time, and may be responsible for setting up the disease many years after the affected animal has died. Every care should, therefore, be taken to prevent contamination of the ground with the blood of a dead or dying animal, and in no circumstances should stock-owners cut, or allow others to cut, the carcass of any animal where there is any suspicion that it has died from anthrax.

Information about this disease is given in Animal Health Leaflet No. 30, which may be obtained free and post free from the Ministry at 1 St. Andrew's Place, Regent's Park, London, N.W.1.

For the Farm Mechanic Mr. H. J. Hine is well known to readers of this JOURNAL as a frequent contributor of articles on agricultural machinery. In that increasingly complex and gaily coloured world, from the mammoth combine harvester to a set of diminutive punches

on the farm workshop rack, Mr. Hine is essentially one of the *cognoscenti*. But his genius lies in his understanding of the needs of the non-technician and in his ability to explain clearly "what makes the wheels go round".

For this reason his *Farm Mechanics Notebook*, published by the Farmer and Stock-Breeder (7s. 6d.), will be widely welcomed. As it comes from the publishers this book has a neat green cover with gold lettering down its spine, but the likely usefulness of the alphabetically-arranged notes makes it certain that its pristine beauty will soon be marred. Two short extracts may serve to show the book's practical value.

OIL DRAG. Cold, thick oil on bearing surfaces causes drag and can make machinery very hard to turn. This is particularly noticeable in starting heat engines, because the grade of oil used has to be suitable for the high running-temperatures, and therefore is very thick and sticky when the engine is cold. Sometimes it is worth while to warm an engine by playing a blow-lamp flame on to it very carefully.

In the case of a tractor, much of the drag is in the change-speed gearbox, and the swinging of the engine can be made by holding the clutch out of engagement so that none of the gears in the box has to revolve.

COMBINE DRILLS. For use in combine drills the fertilizer must be dry and free-running. Manure that has set into lumps should be broken up on a floor and sieved before being put into the drill.

The drill must always be kept dry. Most fertilizers corrode metal as soon as they become only slightly damp. All parts must be cleaned immediately after work, then oiled, or, better still, they should be dismantled for cleaning and dipped in oil before they are reassembled.

When the drill has to be left out in the field overnight all the fertilizer should be run out and the drill covered with a waterproof sheet.

Rations for Livestock: Winter 1949-50

The only changes in the ration scales for livestock in England and Wales during the coming winter, compared with those for last winter, are the undermentioned increases in pig rations and the farrowing sow allowance, and the new rations for calves aged 6–12 months.

COMMERCIAL PIGS. *Basic rations* for pigs will be provided at the winter scale of 1 cwt. per pig in respect of 22½ per cent (9/40th)—instead of 20 per cent as hitherto—of the numbers registered as kept on holdings in 1939 or 1940, less a deduction of 1 pig for each 64 acres of the holding.

Extended Scheme. Rations will be issued for the new specified numbers (according to acreages) already announced (see the June, 1949, issue of this JOURNAL, p. 130).

Farrowing Sow Allowance. This allowance has been increased to 9 units for each sow or gilt about to farrow. Applicants may, if they wish, have the whole of the 9 units in cereal and protein coupons; otherwise the allowance will consist of 3 units of National Pig Starter Food and 6 units of ordinary cereal and protein coupons. This National Pig Starter Food has been designed specially to provide for the needs of young pigs, and contains a higher minimum proportion of protein than existing pig foods.

CALVES 6–12 MONTHS OLD. From October, 1949, to April, 1950, inclusive a monthly ration of ¼ cwt. protein and ¾ cwt. cereal will be issued *on application* for all calves being reared for milk or beef, irrespective of whether milk is sold off the holding. This has been made possible only by an improvement in the short-term prospects for imports of animal feeding-stuffs from non-dollar sources, and there can be no promise that it will be

repeated next year. The existing arrangements for the provision of special calf food for calves under 6 months old remain unaltered.

A free leaflet giving full details of livestock rations will shortly be available from the Ministry of Agriculture and Fisheries, 1–3 St. Andrew's Place, Regent's Park, London, N.W.1.

Nature Month by Month—October

The sloe bushes are heavily laden, and the solitary crab-apple tree in the farmhouse hedge still bears its crop of yellowing fruit. Nowadays, sloe gin is rarely made in these parts, but the crabs may yet be gathered for jelly-making. There are still many blackberries in the hedgerows, most of them past their best. In past years I have seen blackberries hanging as late as the first week in November. Even the wood-pigeons, it seems, become surfeited with them in time.

The hedgehogs are restive, now, seeking their winter quarters. On the roads, at night, regrettably, the faster traffic takes heavy toll of the wandering urchins. Was there ever such a year for hedgehog casualties? Such dormice as are still with us will have forsaken their summer haunts in hedge and bush for more substantial nests on ground level or below it. It is a long time since I saw a dormouse here. There are places where, as a boy, I could always count on finding one in summer, but not now. For years they have been growing steadily scarcer.

On the Michaelmas daisies in the garden and the ivy blossom in the lane there are still red admirals and small tortoiseshells, with a few drowsy bluebottles, hoverers, and other small winged insects. Our last year's invasion of the swift, tubby little humming-bird moths seems not to have been repeated. Last autumn there were more of them than I had ever seen before.

The woods are almost silent now. The harsh note of a jay—quick as ever to detect and resent a human, a distant tapping that might be nuthatch or woodpecker, a flutter of wings telling that the wood-pigeons are at the beech-mast, are all the sounds that reach my ear.

Far out on the Moor, on this sunny October day when the autumn gales have yet to come, there is an almost uncanny quiet, and when I passed the Moorman's hut a few hours back the smoke from his fire rose straight as a reed into the sky. Overhead a buzzard circles lazily. A belated bee fusses about in the herbage by my feet. Very far away a sheep-dog barks. Over all the Moor there is no other sight or sound of living thing. The uprights of the stone circle by which I sit are green and grey with moss and lichen. How old are these ancient circles—two, three, five thousand years?

By the biggest pool in the river the foliage of the great beeches is turning. Soon it will be a mass of gold and russet, touched with crimson here and there. The rippling wake of a disturbed water-vole has died away, and the pool itself is very still, with no visible rise of trout nor sign of fly upon the water.

One must make the most of these lovely, short October days. All too soon they will be gone and winter will be on us.

F.H.L.

BOOK REVIEWS

Feeding Poultry. GUSTAVE F. HEUSER. Chapman and Hall. 30s.

Within the last thirty years a revolution has taken place in methods of poultry-feeding. At the beginning of the present century poultry-feeding was based on tradition; now it is almost an exact science. Accompanying this revolution in feeding methods, many changes in systems of management have occurred, and poultry are now bred and reared at all times of the year, and often under very artificial conditions. Errors in feeding under such conditions quickly lead to disaster, and in consequence there is a demand among poultry-keepers for books which give in simple language the results of modern developments in poultry research, as well as practical guidance in constructing suitable rations.

This book attempts to supply that want, and does so in a pleasing and attractive manner. Beginning with a short description of the food nutrients and the digestive processes of the fowl, a large section is devoted to the description and uses of the more familiar, as well as some unusual, poultry foods. This is followed by a consideration of the factors to be noted in constructing rations, the management and systems of feeding suitable for various classes of poultry, and rations for rearing, for egg production, for the production of hatching eggs, and for the fattening of poultry. The latter chapters deal with the feeding and management of water fowl, turkeys and game birds, with a final chapter on the economics of feeding which should prove of special interest to the economist and others interested in the relation between food consumption and egg or meat output.

Altogether this is a readable book and worthy of the attention of farmer and student alike. The information on the value and uses of feedingstuffs, together with the numerous practical mash mixtures given, will appeal to the farmer; to the student the bibliographies at the end of each chapter, together with the results of poultry nutritional research up to the date of publication of the book, given in a readable and critical manner, will be particularly welcome.

E.T.H.

Good Control of Insect Pests. S. G. JARY. English Universities Press. 4s. 6d.

This interesting book by Mr. S. G. Jary is a welcome addition to the "Teach Yourself Farming" books. It is not meant to be a conventional textbook, however, nor yet an encyclopædia of insect pests. As the author says: "There are already many publications in which pests are described, their life histories detailed and methods for their control stated as simply as possible."

The reader will find, however, that besides dealing realistically with the principles and practice of pest control, Mr Jary has contrived to include the life histories of the more important pests of agricultural and horticultural crops. He has also dealt thoroughly with the nature and properties of the principal insecticides and their preparation and use. It is a very useful reference book for the farmer, the fruit-grower and the student, and has the stamp of a competent authority.

W.A.R.D.W.

Gall Midges of Economic Importance. Vol. III : Fruit. H. F. BARNES. Crosby Lockwood. 15s.

Volume III of this monograph has been looked forward to eagerly by all economic entomologists and fruit specialists. None will be disappointed; the high standard we have come to expect from Dr. Barnes is well maintained. The fruit gall midges of economic importance in the British Isles are dealt with very fully and the information on control measures is up to date enough to include reference to results with DDT insecticides.

As in Volumes I and II, emphasis is laid on biology and control rather than on descriptions. Gall midges are highly specialized insects, and it is exceptional to find one species attacking more than a few very closely allied plants; frequently one midge is confined to one plant. Diagnostic and descriptive characters are therefore reduced to an absolute minimum and the work will have a very wide appeal. Not only is it certain to become a reference work for the economic entomologist and fruit specialist for many years to come, but many fruit-growers who have themselves become specialists will read it from cover to cover.

The index is in three parts—a plant index, a midge index and a general index—and there are very useful notes on the economic importance of all the host plants. The text is illustrated by nine plates of excellent photographs—mainly of midge damage to fruit trees and bushes of economic importance in Great Britain.

I.T.

BOOK REVIEWS

Labour Organisation in Milk Production. CAMBRIDGE UNIVERSITY. Farm Economics Branch Report No. 32. 5s.

Following studies of the use of labour in the cowhouse, a number of American publications have included detailed discussion and advice on dairy "chore practice" or cowhouse routine. Some of the findings and recommendations are applicable to dairy farms in Britain, but, in general, the problem is complicated in this country by a greater variation in herd size and by the use, on many of our farms, of old and inconvenient buildings. There is, therefore, a great need for more information on the subject in Britain, and the Cambridge report is valuable not only in providing data on labour organization in the cowhouses of the eastern counties but also in pointing the way to more work of a similar character elsewhere.

Justification for investigation of the subject is very evident from the fact that the equivalent of about one-fifth of the full-time farmers and workers in agriculture are employed on work in the cowhouse, while about 30 per cent of the cost of milk production is due to expenditure on labour.

The report includes useful data on the superiority in labour economy of machine milking over hand milking, of the large herd over the small, and of the yard-and-parlour system over the ordinary cowhouse. It also shows the time spent on the various jobs in the cowhouse, emphasizing the amount of time spent on actual milking, especially in small hand-milked herds. The aspect of the study that is of particular importance is the evidence of the wide farm-to-farm variation in labour consumption in the cowhouse. On one farm it may be more than twice as much as on another farm of similar size and with similar buildings. It is clear that with the present cost of labour, many inconvenient cowhouses should be demolished or reconstructed. It will be some years before materials and building labour will be available to make this possible on a large scale. The report, however, also shows that great differences in labour consumption in the cowhouse are due to ***routine***, particularly at milking time, and alterations in routine can be made immediately. It is evident that there is much future work for the adviser on cowhouse routine. But milking also affects milk yield and even milk quality. Thus there is a need at present to integrate carefully the findings of the economist, the physiologist, the dairy engineer, and the bacteriologist, and to translate their findings into a simple practical routine for the various types of dairy farm.

A.S.F.

Rothamsted Experimental Station Report for 1947. 3s.

As in the Report for 1946,* the abridged report for 1947 contains, as well as the separate progress reports of the specialist departments of the Station, brief articles reviewing the progress of some particular line of investigation.

One looks forward to these reviews, for, apart from their interest to the specialist reader, they give a bearing on the direction in which work on certain problems is heading, and indicate how the work at Rothamsted links up with related investigations elsewhere. The two subjects reviewed in the present report, by the Departments of Physics and Plant Pathology, respectively, concern the electric charge on soil particles and work on potato virus diseases.

Among the many points of general interest dealt with in the Report, mention may be made of the following:

The experiments on deep v. shallow ploughing in progress at Rothamsted and at many other centres (now in their fifth season) have shown some interesting results. Sometimes, but not often, very marked differences in favour of deep cultivation have been observed. Fertilizer placement studies with potatoes have shown that broadcasting fertilizer ***after*** ridging is much sounder practice than applying fertilizer before ridging.

The Department of Crop Physiology has begun a new series of experiments to determine how cultivation or fertilizer action affects the activity of the rooting system of crops, so as to bring about differences in yield. The work of the Department of Botany on the vitality of buried weed seeds is nearing completion. Special attention is now being paid to the problem of wild oats.

Arrangements are now completed for the setting up at Rothamsted of an Agricultural Research Statistical Service to assist agricultural research stations, the N.A.A.S., and similar bodies, in experiments and surveys involving statistical problems.

The Report includes the first progress report of the new Department of Pedology which is carrying out fundamental studies bearing on soil formation.

A.J.L.L.

*Reviewed in the August, 1948, issue of this JOURNAL, (p. 228.)

BOOK REVIEWS

Economics of Soil Conservation, ARTHUR C. BUNCE. Iowa State College Press. 18s.

This is the third printing of a book that first appeared in 1941. Two glaring misprints strike the eye on the first page, and it is a pity that these and several others were not corrected before the reprint was made.

As far as the reviewer is aware, this is the only book that has appeared on the subject. It may come as a surprise to many soil conservationists who thought that the economics of soil conservation were concerned mainly with the question whether it would pay to fertilize, or how much a mile of terracing would cost, to learn that the heart of their problem is "the determination of the proper rate of discount on the future with respect to the utilization of our natural resources". In this book they will learn the part played in soil conservation by the interaction of fund and flow resources, by individual value judgments, by social time preferences, and by many other things which at first sight make the jargon of soil literature read by comparison like beautiful poetry. It is the author's aim to describe the forces which determine whether or not a government will loosen its purse strings to preserve the national inheritance of land, and the forces which stimulate a policy of conservation. Recognition is steadily growing that soil conservation is a social problem—and social problems have an economic basis. A book such as this is indispensable to a full appreciation of the social aspects of conservation. *G.V.J.*

BOOKS RECEIVED

New Biology. Edited by M. L. JOHNSON and M. ABERCROMBIE. Penguin. 1s. 6d.

Ploughman's Wisdom. NORMAN CAREW. Faber. 15s.

Manual of Cultivated Plants. L. H. BAILEY. Macmillan. £4 7s. 6d.

Farm Work Simplification. LAWRENCE M. VAUGHAN and LOWELL S. HARDIN. Chapman and Hall. 17s.

Fungi and Plant Disease. B. B. MUNDKUR. Macmillan. 16s.

Manual of Bacterial Plant Diseases. W. J. DOWSON. A. and C. Black. 16s.

Introduction to **Packaging: British Standard Packaging Code.** BRITISH STANDARDS INSTITUTION. 4s.

Turkeys and Geese. HERBERT HOWES. Macmillan. 6s.

Suppression of Weeds by Fertilizers and Chemicals (3rd Edition, Revised and Enlarged). H. C. LONG and WINIFRED E. BRENCHLEY. Crosby Lockwood. 7s. 6d.

Gall Midges of Economic Importance. Vol, VI: Miscellaneous Crops. H. F. BARNES. Crosby Lockwood. 15s.

The Law of Agricultural Holdings. W. S. SCAMMELL. The Royal Institution of Chartered Surveyors and The Chartered Auctioneers' and Estate Agents' Institute. 25s.

Changes in the Economic Organisation of Agriculture: A comparative study of conditions in the Eastern Counties of England between an identical sample of farms in 1947-48. (Farm Economics Branch Report No. 33). UNIVERSITY OF CAMBRIDGE, DEPARTMENT OF AGRICULTURE. 5s.

The Modern Dairy Goat. JOAN and HARRY SHIELDS. C. Arthur Pearson. 7s. 6d.

The Story of Bovine Tuberculosis. STANLEY M. FORSYTHE. C. and J. Temple. 10s. 6d.

Introgressive Hybridization. EDGAR ANDERSON. Chapman and Hall. 18s.

Good Control of Plant Diseases. H. H. GLASSCOCK. English Universities Press. 4s. 6d.

"AGRICULTURE"

Price 6d. net monthly, post free. (Foreign countries, 8d. post free).

Subscription Rates (including postage) :

Inland and Imperial .. .. 6s. per annum
Foreign Countries .. .. 8s. per annum

Subscription may start with any issue and should be sent to

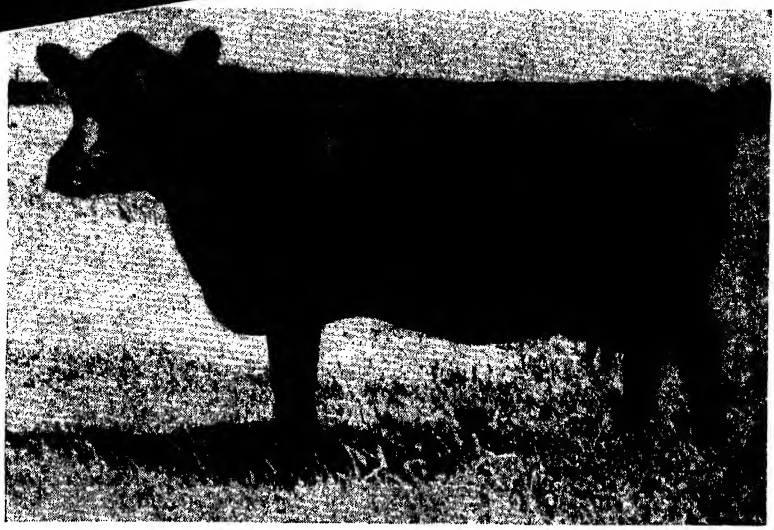
H.M. STATIONERY OFFICE

York House, Kingsway, London, W.C.2; 13a Castle Street, Edinburgh 2; 39 King Street, Manchester 2; 2 Edmund Street, Birmingham 3; 1 St. Andrew's Crescent, Cardiff; Tower Lane, Bristol 1; 80 Chichester Street, Belfast.

Single copies can be purchased from any of the above-mentioned addresses or through a bookseller.

Printed in Great Britain under the authority of HIS MAJESTY'S STATIONERY OFFICE by C. Nicholls & Company Ltd., The Philips Park Press, Manchester, London and Reading

Rasen Beauty



FOR THE *Best* RESULTS

BIBBY Foods for all farm stock are always in line with the latest practical research and actual feeding tests on the BIBBY experimental farms. This is but one of the many reasons for the deep and widespread confidence in these feedingstuffs.

RASEN BEAUTY (illustrated above) gave 13,709¼ lbs. with her third calf, and has already given 8,617¼ lbs. with her fourth calf in 199 days. Now giving 33 lbs. per day—RASEN BEAUTY (the property of J. F. Rowson, Esq., Manor Farm, Thorpe, Wainfleet, Lincs.) was fed on BIBBY'S No. I CAKETTES.

It will pay you too, to feed BIBBY Feeding-stuffs, and our local agent will be pleased to give you full details of the BIBBY range.

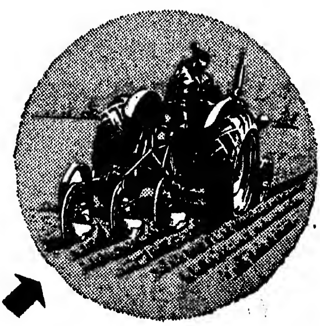
BIBBY Feeding Stuffs

· BIBBY AND SONS LIMITED · LIVERPOOL · 3

3408E

Greater FARMING ECONOMY

POWER enough for the job, the right implement to do it well and economical running costs — these are the things that have made the Fordson Major Tractor the most economical power unit for the modern farm. The Major is the World's lowest priced tractor in its power class and costs least to maintain. Spares and mechanical repairs are at fixed low prices. The Major leads with its fine range of mounted implements. There are no less than five models of the famous F-R Plough alone. The Deep Digger version is shown above. It is strongly built, easily handled and very compact for short headlands. Mounted on the Major's Hydraulic Power Lift, it can be lifted for turning or transport at the touch of a lever!



This is the well known 3- 2 furrow model of the F-R plough. General purpose, semi-digger and deep digger bodies are available and there is a choice of share points. Earth wearing parts for all F-R ploughs are easily obtained from your nearest Fordson Tractor Dealer.

Fordson

MAJOR TRACTOR

You get more work out of a Fordson

FORD MOTOR COMPANY LIMITED, DAGENHAM

Please mention the JOURNAL *when corresponding with Advertisers*

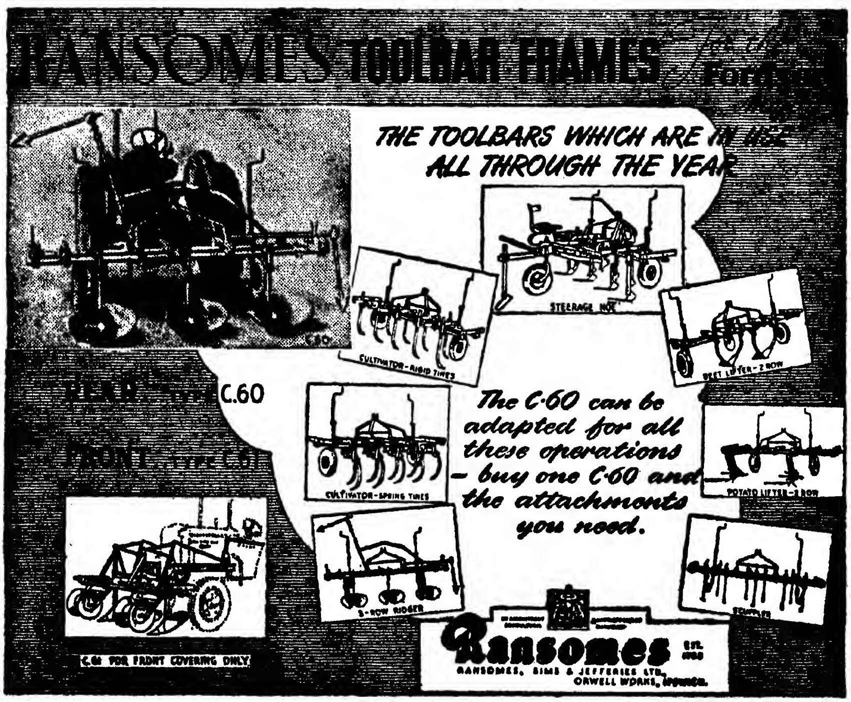
THIS IS THE DEOSAN ROUTINE FOR

clean milk production

1 Eliminate grease by cleansing with Deosan Dairy Detergent	**2** Eliminate germs by sterilising with Red Label Deosan (Approved hypochlorite)

Simple, safe, economical, the complete Deosan Routine for cleansing and sterilising dairy utensils is a positive safeguard against milk-souring bacteria.

DEOSAN LTD: 345 GRAY'S INN ROAD, LONDON, W.C.1
(Associate Company of Milton Antiseptic Ltd.)



Please mention the JOURNAL *when corresponding with Advertisers*

72-1-10-49

Agriculture

PUBLISHED 6d MONTHLY

Please mention the JOURNAL *when corresponding with Advertisers*

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

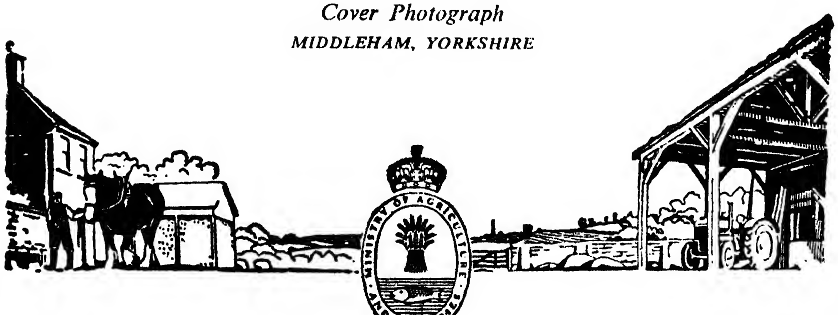
Editorial Offices: St. Andrew's Place, Regent's Park, N.W.1 (*Phone: WELbeck* 7711)

VOL. LVI | No. 8 | NOVEMBER 1949

Contents

Cover Photograph

MIDDLEHAM, YORKSHIRE



AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LVI No. 8 NOVEMBER 1949

LEYS GOOD AND BAD

WILLIAM DAVIES, D.Sc.

Director, Grassland Research Institute, Stratford-on-Avon

THE farmers of Britain have achieved much since 1940. Before the war England and Wales had some 16 million acres of permanent grass, of which the bulk was of poor quality and much completely unproductive. During the intervening years the area in permanent grass has been reduced to about 10 million acres, tillage crops have gone up in proportion, and there has been a substantial increase in the area in under leys. This movement was started in the spring of 1939, and great strides were made during the crisis years of the war. But since 1945 the pace of development has abated ; in fact the acreage under permanent grass in 1945 was as low as it is today. In the realm of rough grazings, of which there are 5½ million acres in England and Wales, we have done comparatively little, although there have been important additions to our knowledge relative to developing our marginal and hill lands. As a country we may or may not be at the optimum of tillage acreage, but we are certainly not at optimum in relation to the acreage of permanent grass on the one hand and good leys on the other.

It has been said in some quarters that the agriculture of this country is still no more than at "half-cock". This may or may not be true generally, but we are certainly at less than "half-cock" (considerably less in fact) in relation to our grassland production. The land still in permanent grass is not "pulling its weight" in the national effort towards increased food production. The permanent grass still remaining is, by and large, of poor quality, and far too much of it is just lying idle. Even at its best, permanent grass offers no real flexibility when compared with the potentialities that are offered by a well-farmed and productive ley.

It is true that many farmers of a pioneering type of mind have made themselves high-class ley farmers. They are using the ley in all sorts of ways which were largely undreamed of ten years ago, but the proportion of good leys in relation to the whole, particularly long-duration leys designed for three years and upwards, is appallingly small. It is doubtful if many of those who have had only limited experience of dealing with leys realize how poor, in fact, their leys are. Many of the leys one sees up and down the country are poorer and less productive than the permanent grass which they replaced, bad as that often was.

Experience goes to show that one of the many reasons why we still have so much permanent grass in the country is that the technique of establishing and maintaining high-class leys has not yet become common property among the farming community of the country. Those farmers

who have, in fact, learned the technique and the tricks associated with the maintenance of high-class leys have seen the good effects of having such leys established on their farms, and, once that has come about, permanent grass is quickly reduced.

Seeds Mixtures I believe that the general standard of the long-duration ley in Britain has gone down since 1945. A large proportion of the leys now being made up and down the country are being sown with fairly poor seeds mixtures. Not nearly enough emphasis is placed on manuring for high production, and the technique of establishing the ley is often bad. Even after establishment of the ley, there is much that can be criticized in the subsequent management of the sward. With regard to the technique of establishment, leys are far too often sown under corn, which is quite definitely a smothering crop in so far as young seeds are concerned. Far too often, also, too much Italian ryegrass is included as part of the seeds mixture. Italian ryegrass itself is a smothering species, and after it dies out it leaves bare patches in the pasture. Italian ryegrass is a valuable ingredient of the shortest duration leys, particularly as a grazing plant in the one-year pasture ley, but it is dangerous to use it as an ingredient of long-duration leys, except on the poorer types of soil and on hill land.

Too often seeds mixtures which otherwise may be balanced are being based on commercial strains of the several grasses and clovers, and far more emphasis needs still to be placed on those strains which are not only long-lived but are productive throughout their whole life. This is particularly true in the case of Irish and Ayrshire ryegrass, both of which are short-lived and unproductive, except at the very highest levels of soil fertility. In the case of cocksfoot, we are still using far too much of the imported stemmy types, and similarly we use American, Canadian and Scotch timothy, all of which are stemmy, short-lived and relatively unproductive. So much for the seeds mixtures.

Soil Fertility Now to the question of soil fertility, particularly in terms of lime and phosphates. Taking our country by and large our soils are desperately short of lime and phosphates. In many areas potash is equally important, and experience has shown that high-class leys are more responsive than any other crop to the knowledgeable use of nitrogen. At the present moment the value of building up the lime and phosphate content of soils under ley is not by any means fully appreciated. The clovers are an essential basis of the high-class ley and, without adequate phosphates and lime, clovers will not thrive; neither will they thrive without potash where that is a limiting factor in the soil. There may be other plant foods such as the so-called trace elements which are needed, but we know little about these as yet and they need not, at the moment, bother the ley farmer *unduly*. We may, however, have to face up to this question in the future after more experimental evidence has been obtained.

Having established the ley and taken precautions to feed it properly, there should be no need for the rapid deterioration which does take place over so much of the country at the present time. In the maintenance of the ley, however, reasonably sound management should be applied. If hay is taken from the ley every year and little or no grazing afforded, then that ley will soon deteriorate and become unproductive. In general practice, therefore, it is preferable to alternate the management of a particular ley instead of having the same management year after year. The modern concept of good management should be not whether the pasture

looks well at any particular time, but whether or not it is producing at high level throughout its whole life. It should be capable of starting growth in the early spring, producing feed right through the driest of summers and capable also of producing into the late autumn and early winter. A good ley can be manipulated to do any of these things, but it may not be able to do them all in the one year; nor will it do them in every year if the same treatment is carried out on a particular field year after year. Therefore, alternation of management and treatment is sound practice in the maintenance of high-quality leys. The crux of the value of the ley is whether or not it is *producing at high level and doing that consistently.*

Good Leys pay a Dividend To sum up, bad leys are altogether too common throughout the country and, if we are to get the best out of our land, the country must look to the betterment of its leys as well as looking to its permanent grass. Sowing leys under corn is bound to jeopardize them from the start and to make their maintenance that much the more difficult. Using the wrong seeds mixtures is equally unsound. The advisory officers of the country can put you right on that score.

So, also, with the question of soil fertility—usually a matter of lime and phosphates, with the proper and knowledgeable use of potash. Given proper establishment of the sward and adequate maintenance of soil fertility, then the well-being of the ley depends largely on good management. Look to your leys, for it is the ley which will produce milk and meat, and once you know how to deal with the ley at its best you will soon want to plough up your permanent grass. On the better soils you will want to crop and then to put the land down to good leys. On the marginal lands and poorer types of soil you may need only the *shortest* of arable rotations and the *longest* of grass rotations consistent with keeping the new leys at high production. *Bad* leys are a menace to British agriculture—*good* leys pay a handsome dividend to both farmer and nation.

individual fields. In this way flexibility is provided without changing the crop sequence, which used to be (and should remain) inviolate. Flexibility in modern farming there must be, but this should come from different rotations and not from the crop sequence of any particular rotation. Special-purpose leys allow this and, fitted into rotational systems of farming, are a sure means of increasing output while building fertility.

Ley Rotations In days gone by much of our light land was farmed on a rigid four-course system: roots—barley—seeds—wheat. This rotation is now almost a thing of the past, and in departing from it there is a danger that some of our land may be farmed in a manner not conducive to restoring maximum fertility. In passing from rigid to flexible systems, there is a tendency everywhere to practise "free rotations". By free rotations we mean systems of cropping where fields are sown to leys not in accordance with a well-conceived plan, but when they have been over-cropped and are overdue for a rest in grass. Such fields when down to grass will often be exploited for grass production and ploughed again if expedient to do so in the interests of further cash cropping or when the ley has ceased to be productive. Such free rotations bode ill for British farming and may not sustain us in the years that lie ahead.

The introduction of the ley into any farming system must be well conceived in time and purpose. At the time of sowing the farmer should know how long he intends the field to remain in grass, and in designing the management for each year of its life he should have clearly in mind the dual function of the ley: namely, the production of grass and the restoration of fertility. Although a restorative crop, the ley does not bestow its recuperative powers automatically. Balancing the use to which a field is put in the interests of present production and supplying the needs of the soil for future production requires careful judgment and skilful planning. It is the hall-mark of real ley farming.

Some farmers on light land have ceased growing roots for sheep and now practise a six-course shift as follows: ley—ley—ley—wheat—barley—barley (undersown). This system is spreading with mechanized corn growing: the leys, dual-purpose in type, are often used for sheep and beef stores. By sowing special leys, this rotation could be modified as follows: grazing ley (sown direct)—grazing ley—wheat—barley (undersown)—hay—barley. Such a system grows more grass and returns more fertility, while avoiding the danger of three successive corn crops. Where root crops are an important part of the farm income the directly sown grazing ley can be used to very good purpose. A sensible rotation would be: grazing ley (sown direct)—grazing ley—potatoes and beet—barley (undersown)—hay—wheat. This again is a six-course shift.

Once the conception of resolving the dual-purpose ley into its component parts is fully appreciated and properly understood, the possibilities for new and novel rotations are almost infinite. Underlying them all is the idea of sowing the grazing ley direct; a technique developed during the war, still in its infancy and bidding fair to become one of the most fruitful developments in modern farming. The keep from direct seeding is known as "maiden" grass—a product that stimulates milk yields beyond what is normally associated with ordinary spring grass. Further, maiden grass from a March sowing is often a safeguard against July-August drought—an asset of inestimable value on every stock farm.

Stocking Leys How should leys be managed? On some farms the grazing is lenient, on others intense, but nearly always it is continuous. The greatest single factor which controls the output from grazing leys is the method of stocking the fields. It is this continuous grazing, whether heavy or light, which reduces the output of leys. Grazing must be controlled for leys to be highly productive; only in this way can optimum output be sustained and maximum fertility restored. In designing management there should be definite rest periods; these must be provided for and the herbage available at any given time eaten off as quickly as possible. Increased output will be related directly to the length of the different rest periods (the longer and more varied the better) and the length of the grazing (the shorter and more varied the better). In other words, greater output and enhanced fertility will be secured only by on-and-off grazing, with short "on" and long "off" periods, the actual dates of resting and grazing being varied as much as possible from one year to the next.

Towards the end of the season, plans should be made for early keep the next year. This can be done by resting fields in the autumn, but never rest the same field at the same time in two succeeding years. When preparing for early bite ring the rest changes as much as possible from field to field. Early silage cuts can be obtained in the same way, but these again should not be taken from the same field year after year. Producing grass at different times of the year is all a matter of resting and manuring at carefully selected periods.

One of the greatest attributes of these new strains is their ability to form numerous side-shoots or tillers from buds at or near ground level. Tiller formation is very important because most grasses die quickly if grazed continuously and keenly without steps being taken to stimulate the buds into active growth. The capacity of a plant to produce tillers is determined by its internal mechanism, but the number of tillers actually formed is influenced greatly by management. Harrowing, cutting and grazing may all be important in stimulating the grass buds to active growth, but the continuous development of tillers after stimulation of the buds is dependent on a regular supply of available plant nutrients, especially nitrogen and phosphate. The new strains, being inherently such prolific tiller-producers, cannot develop their full potential unless manured on a generous scale; and assuming adequate supplies of lime, phosphate and potash, nitrogen exerts the master influence on grass growth. Here I am conscious of entering what has become a rather controversial field. The controversy, however, is more apparent than real. The point to bear in mind when top dressing is to apply nitrogen at different times to the various fields, and at different times to the same field in succeeding years. The increased growth must be consumed quickly; this again points to stocking heavily for short periods with long rest intervals. Temporary fencing will be needed and the electric fence can be used for this purpose. If the grass cannot be consumed quickly it should be cut and conserved in the leafy stage. This too calls for discrimination. Poor fields should not be top dressed and cut for silage; they should always be grazed. If growth is more than can be controlled by the stock, silage cuts must be taken from the fertile fields.

Ploughing Leys One last word. Plough the ley in full vigour—nay, more; dung it heavily and then plough down. This advice is easy to give but hard to take. We have not yet reached the stage of ploughing leys in full active growth. To do so, nevertheless, is implicit in all I have been trying to say; leys must be ploughed at the appointed time, and their management, of set purpose, should be designed to ensure that the

sod, when turned in, is full of white clover and actively growing grass roots. Unless this is done the ley, be it never so productive, will not have served the needs of the soil. I repeat: plough at full vigour; the land will then be farmed for optimum use at maximum need, and this is real ley farming.

The difficulties of ley farming are many: fencing, watering, lay-out, and, not least, changing price emphasis. All these make sound rotations difficult to plan and costly to practise. The needs of the land and the needs of the nation are rarely, if ever, the same at any given time, but they must surely be closer now than ever before. Ley farming, properly understood, is high farming. This is the overall need today, but it must be practised on a fertility-building basis or the land and the nation will ultimately suffer.

A SUCCESSION OF CROPS FOR DRYING

R. E. SLADE, D.Sc.

My aim is to produce: (a) dried lucerne meal of 18-22 per cent crude protein, either made into cubes for feeding with cereals or sold as meal to be made up with cereals into dairy rations; (b) dried grass, including barley and rye, with 15-18 per cent crude protein baled and fed at 23 lb. per head for maintenance and the first three gallons of milk; and (c) selected lucerne meal with 15-18 per cent fibre, for incorporation in poultry mashes and pig food.

My first crop, winter rye, was ready for cutting this year about April 20, but it ripens quickly from the leafy high protein stage to the flowering stage in which the protein content is quite low. But it is worth while growing winter rye so that cutting may start at the end of April before the lucerne is ready.

Early in May I start cutting lucerne—and I grow pure lucerne, not mixtures. After four years I plough up the lucerne ley and use the land for crops other than lucerne in the next four years. I grow lucerne without any mixture of grasses because I find that if I grow either cocksfoot or perennial ryegrass with the lucerne it is impossible to get high protein at each of the three cuts, for only by chance are the two species ready to cut at the same time. There is also another reason why I do not grow mixtures. Lucerne does not need an application of a nitrogen fertilizer but grasses must have heavy dressings of nitrogen each year. Although lucerne fixes its own nitrogen, it does not supply enough nitrogen to the crop which is growing with it—at any rate not early in the season.

The lucerne which I have grown for the last nine years has been Canadian Grimm, but I am not able to obtain Canadian seed now, so I am trying Provence and Hungarian varieties this year.

I sow some early-flowering Danish cocksfoot and S.100 white clover for three-year leys on land that has a high water table. This crop receives a good dressing of a complete fertilizer in the spring and at least 8 cwt. of nitrogen fertilizer during the summer, the first dressing being given as soon as the grass begins to grow. From these fields I can get 3 tons of dry matter per acre each year.

We do not know yet what are the best strains of cocksfoot or ryegrass to grow under these conditions of intensive fertilizer dressing. It would be interesting to see trials made of different strains. I consider that cocksfoot is a much more useful grass to the drier than perennial ryegrass, for the latter throws up flowering shoots so quickly; and there is no difficulty in managing cocksfoot if it is being mown three times a year. It does not tend to form tufts as it does in pastures which are not mown regularly.

This year I have put down a straight cocksfoot ley for three years without any clover. I am relying upon the residual nitrogen from the lucerne crop to make an important contribution towards the nitrogen required by the crop during the next three years. I hope I shall find that I can grow a heavy crop without high applications of nitrogen.

The following Table shows the sequence of crops which I have cut this year. Starting with winter rye on April 17 and then starting to cut my first crop of lucerne on May 2, the first fields are cut when the lucerne is 12-18 inches high and long before it has come into flower.

Acres	Date	Crop	Crude Protein	Fibre	Weight		Weight per acre
			per cent	*per cent*	*tons*	*cwt.*	*cwt.*
7	Apr. 17 May 2	Winter rye (1st cut)	15-18	—	7	7	21
7	May 2	Lucerne (1st cut)	21	14	6	8	18½
16	May 5	do.	23	15	9	2	11½
17	May 10	do.	22	15	16	14	19½
15	May 18	do.	21	18	23	17	31
7	June 1	Winter rye (2nd cut)	12	—	8	3	23
10	June 8	Lucerne and ryegrass	15	25	19	0	38
3	June 16	Barley	10	—	5	14	38
3.5	June 20	New cocksfoot (1st cut)	21	—	3	13	20
6	June 21	Spring rye	18	—	14	2	47
7	June 29	Lucerne (2nd cut)	20	23	9	5	26
16	July 4	do.	19	23	19	13	24
17	July 11	do.	19	25	24	0	28

It will be noticed that the crop on the first lucerne field cut gave 18½ cwt. per acre. This field is early because it is good land on a hill and therefore not so subject to frosts as the other fields. The first crop of lucerne kept the drier employed until June 7, when a second cut of winter rye was taken off 7 acres, and then a field of lucerne and ryegrass was cut. In this field the ryegrass had come into flower, so that the crude protein content of the crop was only 15 per cent, but the bulk per acre was high—38 cwt. After this some barley was cut in the early-flowering stage and gave only 10 per cent crude protein. This barley should have been cut at an earlier stage. A crop of new cocksfoot undersown with S.100 was then cut and yielded 20 cwt. per acre with 21 per cent crude protein.

On June 21 some spring-sown rye was cut, and this yielded 47 cwt. per acre with 18 per cent crude protein. This seems to be the best crop which I have found for filling in the gaps between the first and second cuts of lucerne. On June 29 the second cut of lucerne was started, and this cut will keep the drier employed until the middle of August.

To sum up, my cropping programme, designed to keep the drier working from the end of April to the end of September or later, is as follows :

Middle to end April	Winter rye
May to the first week in June	1st cut lucerne
Two or three weeks in the middle of June	Spring-sown rye or spring-sown cocksfoot
End of June to first week in August	2nd cut lucerne
Two weeks in middle of August	Drier shut down for harvest or drying pea haulm from canning factory
End of August and part of September	3rd cut lucerne and some cocksfoot
End of September and October	Aftermath from hayfields

LATEST DEVELOPMENTS IN WEED CONTROL

Professor G. E. Blackman, M.A.

This Conference is largely concerned with herbage seed production, so I will try and talk about weeds in relation to herbage seed production and bring in some of the new materials which are available for selective weed control.

You will know that there are roughly four types of materials :

(i) Sulphuric acid
(ii) Copper salts
(iii) Growth-regulating substances, such as MCPA and DCPA
(iv) Nitro-compounds—for example, DNOC

There may be an opportunity for pre-emergence spraying against weeds coming up in advance of the crop. Up to now the only material that can be used for pre-emergence spraying is sulphuric acid. The reason you cannot use the others is that all these sprays leave toxic residues in the soil. In the case of sulphuric acid this is not so ; it combines with calcium and forms insoluble calcium sulphate. As an alternative to sulphuric acid, the present indications are that you can use emulsions of diesel oil, which are toxic to many weeds and do not appear to leave toxic residues. It is also possible that other oils which we have recommended for weed control in carrots may also be employed, but more research is yet required.

Although I don't think that pre-emergence spraying in either grass or clover seedbeds is likely to be a normal procedure, there are possibly other materials that can be used for these crops *after* emergence if they are sown direct and not with a cover crop. If you use a cover crop you simply cannot use diesel oils, as they are toxic to the cover crop once the plants are up. If you are sowing your seeds under cereals you must be quite certain that the materials you use will not damage your cover crop or the undersown crop. Grasses, as long as they are in the well-advanced seedling stage, can be sprayed with any of the four groups of compounds which do not damage the cereals. If the grasses are under linseed you cannot use sulphuric acid, or copper chloride ; the best thing is MCPA at the rate of 100 gallons (0.2 per cent solution) per acre. Selective weed control is simplest when grasses are grown alone for seed production, but you must wait until the grass has started to tiller before spraying or dusting. With the growth-regulating substances you can get a complete kill of the crop if you spray when the seedling grasses are just coming through the ground; but when they have reached the seedling stage they are much more resistant. Do not use as much DNOC on grass as on cereals.

Difficulties occur with mixtures : S.23 and S.100 for example. Clover seedlings are not resistant to the growth-regulating substances or DNOC. They will withstand a little copper chloride, but not sulphuric acid. If you have a complete smother of charlock in an undersown crop the spray will probably remain on the charlock leaves and the undersown crop will be protected, and you can use low concentrations of MCPA, DCPA or DNOC. If there are not many weeds do not spray. You will be in trouble if the spray comes into direct contact with the clovers. Research in progress indicates that DNBP* is not as toxic as DNOC to some clovers, but no definite conclusions have yet been reached.

The other development which is coming along is the use of a diesel oil emulsion containing DNBP for the spring spraying of lucerne in the dormant phase for weed control. You can even stunt the grass weeds so that the

*Dinitro - butylphenol.

lucerne will grow away and smother them. There is some indication that there may be a little check to the lucerne with the first cut.

What about the more established grasses where the weeds are of the perennial rather than the annual variety? Growth-regulating substances here are outstanding. The other materials which kill annual weeds have no permanent effect on established perennial weeds. We have experimented with creeping thistle and find that control is all a question of timing. Wait until you see the flower-buds on the stems of the thistle, then spray at once. If you spray earlier the effect will be far less; if spraying is delayed, then again the results will not be so good.

In general, for weed control in fields of established grasses grown for seed, spray in the first half of May, no later. The grasses may be depressed if spraying is delayed beyond this point. The alternative is to cut the crop and spray in the autumn.

Docks can be a nuisance in grasses for seed. You can keep to this late April–early May spraying for seedling docks, or docks in the first flowering year, and get good results. The important point is that there should be a large leaf area at the time of spraying and that the docks should not be old plants.

Turning to buttercups, the creeping buttercup is more susceptible to treatment than crowfoot (*R. acris*). April spraying seems to give the best results. The position is more complicated with the bulbous type; the indications are that the ester-oil emulsion sprays at the flowering stage are the most effective, but the possible injury to grasses being shut up for seed has yet to be investigated, and the decrease in clovers may be very great.

OBSERVATIONS ON LUCERNE

William Alexander, M.B.E.
Eynsford, Kent

THE prolonged dry summer this year has again brought into prominence the value of lucerne to stock farmers, especially those with dairy cattle. The strange reluctance of farmers to put down greater acreages, where the land is suitable, can only be described as one of those things wrapped in mystery and beyond understanding. For it is only a matter of studying the requirements of the plant in the early stages; the remainder is plain sailing.

Type of land has first to be considered, and by dividing it into two classes we have soil on which lucerne will grow and the remainder on which it is hopeless trying to establish it. The first class has many subdivisions, varying from some fertile marshes where the land only requires cleaning, and the seed sowing; then, without any manuring whatsoever (but with suitable management) a stand of some 6 to 8 years is assured. At the other end of the scale, elaborate preparations have to be made during the years previous to sowing to work up the fertility to enable the crop to establish itself. Unfortunately, I am in a low fertility district, and I have often come away with a headache after visiting one of those favoured spots where things just grow.

Notwithstanding this, it is probably in the poorer districts where the greatest benefit is derived by making otherwise unprofitable land produce satisfactory crops. Establishing a ley after a well-dunged crop of roots is a very suitable place in the rotation. But if one has an awkward field which is too far away from the dung cart, or if dung happens to be scarce, there is no need to worry ; green manuring often gives equally good results. On suitable land the ordinary white turnip can give a good account of itself, and on chalky banks it has proved superior to mustard or rape. It has the great advantage of being cheap, and its quick growth enables the land to be cleaned both before sowing and after the crop is put under. June 15 has been found to be a suitable date for sowing (3 lb. per acre through a corn drill), and the turnips will come to maturity by the middle of September. If the manuring has been adequate a large quantity of organic matter goes into the soil. Sheep would, of course, make a nice tidy job, but in their absence a heavy disc harrow or rotary hoe achieves the object, which is to cut up the turnips so that they will not stay intact underneath the ground all winter and be a nuisance the following year.

Spring Wheat as Cover Crop Having got the land in good heart prior to establishing lucerne, we now consider the best method of obtaining a satisfactory plant. There is the strongest possible reason for sowing with a cover crop (not smother crop) of spring wheat about the last week in March or the first week in April. The argument in favour of this is that it is economic, and on my own farms the practice has never been known to fail. This year, for instance, at the time of cutting the wheat, the lucerne was 18 inches high and looking very happy. It is not advisable to aim at more than 4 to 5 qr. of wheat, which requires a thin plant not too heavily manured with nitrogen. The lucerne seed is sown directly after the wheat is sown, and they both come away together, having equal chance for food and light. To expect good results under a thick crop of winter wheat is just asking for trouble—and possibly resowing. The textbooks recommend sowing in early spring without a cover crop—a method which is quite satisfactory where the land can be guaranteed clean of annual weeds. But where there is an affliction of charlock, poppy, chickweed, fat hen and knotgrass, the only thing to do is to stir the land three times a month until the end of June or the beginning of July, by which time it may be considered clean and an excellent plant can be obtained. There is, however, no financial return in the year of sowing, and one has only to count the difference between that and 4½ qr. of wheat before thinking twice about adopting the latter method. It may be argued that a heavier crop will result from sowing without a cover crop, but considering that a stand sown under Atle wheat in 1948 yielded in three cuts 5 tons per acre of dried material in 1949, a pretty good case will have to be put forward.

For the commercial man who is growing just to dry and grind into meal, it is probably best to sow lucerne with, say, ½ lb. of wild white clover. Cleaning can be done in the winter by cultivation or by hard grazing in March. For the stockman, the addition of a suitable grass in the mixture is advisable. To those who say otherwise, I ask, why not grow red clover by itself instead of including ryegrass or other grass for a one-year ley? Lucerne grown by itself does not make an attractive fodder, it is not easy to make into hay on account of the loss of leaf, and cattle much prefer it mixed with some sort of grass. In some districts cocksfoot is given preference and it may be best under some conditions and on some soils, but on chalk it may well be that timothy is the answer. Being a late grass, it is at the right stage for making into early cut hay when lucerne is ready,

and if weather conditions delay cutting it does not run to a hard stalk as does cocksfoot; in fact it makes a delightful mixture which cattle eat with relish. Meadow fescue has also been found very suitable.

The most common fault is to sow too much grass in the mixture, and many a field has been spoilt in this way. With timothy, 2 lb. per acre is usually sufficient. Cocksfoot requires a special method of introduction which necessitates harvesting the wheat first, then broadcasting about 5 lb. per acre and harrowing in. The result is that little is seen of the cocksfoot in the first year of cutting, and the lucerne is allowed to establish itself without interference from the cocksfoot, which will show up in the second year of cutting. In the first year there is danger that lucerne will be unable to keep down natural grasses and that its yield will be low. An addition to the mixture of a small amount of broad red clover has been found to be very useful in making bulk without depressing the growth of lucerne : 2 lb. of broad red per acre has been found enough in some cases to double the yield.

Where lucerne is being sown in a field for the first time, inoculating the seed just prior to sowing may be regarded as a form of insurance to ensure a good "take," and it has in a great many cases meant the difference between success and failure.

The Importance of Manuring and Strain Manuring depends entirely on the type of soil. A sample for analysis should be taken as a guide. Some soils will require lime and more lime, while in chalky districts it will probably be potash and more potash, and in some districts phosphate. It is not always recognized that the heavier the crop removed, the more fertilizer should be applied to make up for what has been taken away. The fact that the dry matter in lucerne may analyse from 3 per cent upwards of K_2O is an indication of what should be replaced. With an experiment on varying applications of potash, the control plot which received none practically faded out after two seasons.

When everything has been done in land preparations, manuring, sowing, etc., there still remains one very important item, namely, the choice of variety and strain. This can make a wonderful difference to the crop. During the war, when no choice of seed was possible, the failure of some strains is no doubt one reason why certain farmers have given up hope of success. In fact, some ghastly failures on my own farms made the selection and developing of a better strain a first priority. Although it is doubtful if seeding lucerne will ever be a commercial proposition, except possibly in a few favoured districts, results have shown it worth while, with very much heavier yields than from ordinary strains. The new French variety, Du Puits, is also giving promising results, and it is hoped that it will prove capable of lasting at least as long as other varieties.

With lucerne, we have a plant capable of maintaining soil fertility, suitable for best quality hay and silage, giving the best continuity of supply in dry districts for grass drying plants, and capable of producing more protein per acre than any other plant we grow. Yet it is not taken seriously by the majority of farmers. To those who call themselves farmers but continue to put lucerne down under any old conditions and then grumble about results, there is only one answer : "You have got what you asked for, why expect any more?"

SILAGE IN HERTFORDSHIRE, 1948

W. LEWIS and A. EDEN, M.A.
National Agricultural Advisory Service, Eastern Province

PRESENT-DAY shortages of feedingstuffs make it increasingly necessary for farmers in Great Britain to make full use of home-grown foods, and in this connection more and more are turning to silage-making as a means of providing a valuable source of food for their cattle over the winter months. Farmers have definitely become silage-conscious, largely as a result of publicity and demonstrations by officers of the National Agricultural Advisory Service and by the examples of their neighbours. Now that the principles of good silage-making are well established and becoming more widely known and appreciated, the difficulties with this form of conservation of fodder crops are much less than they were ten years ago, and experience shows that more and better quality silage is being made than ever before.

Quality in silage implies, first, a product which is free from appreciable waste, pleasant to handle and smell, and secondly, a material relatively high in feeding value, particularly in protein. For assessment of the latter, samples of silage are taken by District Advisory Officers of the N.A.A.S. and sent to the laboratory at the Provincial Centre, where they are analysed and reported upon for feeding value. In this way the Provincial Nutrition Chemist gets a comprehensive picture of the silage position in each county, and thus it is possible to watch the progress of the silage campaign and assess its general results.

In the Eastern Province during the autumn of 1947 it was decided to attempt an intensive survey of silage quality the following season in one county, by inspecting and analysing samples of all the silage made within that county. Hertfordshire was selected for this purpose, since there were a number of established silage-makers there and the burden of analytical work was not likely to exceed the resources available to deal with it. The County Agricultural Officer, Mr. R. Line, and his District Advisory Officers, Messrs. Dunnett, Scragg, Naylor, and Morley, were enthusiastic about the idea and promised wholehearted co-operation. Accordingly a campaign was arranged, aided by lectures and demonstrations, for the 1948 season, and plans were made for samples to be taken as the silage was being fed. The farmers were keen and responded well, and the sampling was carried out over a period of six months. By the middle of April, 1949, it was estimated that at least 90 per cent of the silage made in this county had been analysed, and in one district the actual known figure was 96 per cent. The silage which had not been sampled consisted either of surplus, which remained in unopened silos for use during the summer months, or was from very small silos where the silage had been used up before the county staff was notified. In 1946 the estimated amount of silage in the county was 3,000 tons; in 1948 the figure had risen to 7,000 tons, and in the current year there is little doubt that the figure has again risen considerably.

In all, about 140 samples were received, and for easy reference the following results are expressed on a percentage basis.

Crops Ensiled Classification of the various crops made into silage is not too simple a task, as the following considerations will show. Lucerne, for instance, is a most important crop in the eastern counties, owing to its capacity to withstand drought conditions It is frequently grown as a straight crop, but there is an increasing tendency to grow it with companion grasses, such as cocksfoot and timothy, and less frequently ryegrass is also included. All crops for silage containing lucerne have been

grouped together as lucerne mixtures. Again, it has seemed desirable to maintain some distinction between crops of pure grasses and those containing clover and other legumes, which have accordingly been classed as clover-and-ley mixtures. Oats-and-tares are, perhaps, the traditional silage crop, but on the heavier soils other cereals and legumes (e.g., beans) are often included in the mixture, and for the present purpose it has been decided to distinguish between the traditional mixture and that in which other cereals and legumes have been included. Occasionally, cereals, alone or mixed, are taken in the young stage in early spring for ensiling, particularly where they have been autumn-sown and become winter-proud. The following Table shows the percentage distribution of the silages between the various crops:

Silage Crop Distribution

		per cent
1.	Lucerne mixtures	19.2
2.	Grasses	8.8
3.	Clover-ley mixtures	26.5
4.	Oats-and-tares	16.9
5.	Cereal-legume mixtures	14.7
6.	Cereals (alone or mixed)	5.1
7.	Sugar beet tops	3.7
8.	Pea haulm and pods	2.2
9.	Miscellaneous	2.9

Thus lucerne crops comprised about one-fifth of the total silage, compared with one-quarter for the whole Province. Grass and ley mixtures comprised over one-third, oats-and-tares one-sixth, and mixed cereal-legumes about one-seventh of all the silages. The increase in pea-growing for canning purposes in the eastern counties has stimulated farmers to use the haulm residues from the viners for making into silage, and almost without exception the material is of high protein quality. The percentage of silage made from pea haulm in Hertfordshire is rather low compared with that for the whole Province, where nearly 10 per cent of the total silage received was made from this crop, but when the virtues of pea haulm silage are more fully appreciated there will, doubtless, be a considerable increase in silage of this type. In view of the large acreage of sugar beet grown in the Province, it is surprising to find such a small amount of tops made into silage. Most of the tops, however, used for stock-feeding purposes are fed in the comparatively fresh condition, and quite probably the difficulty of getting the necessary labour during the busy sugar beet harvesting season helps to account for the low proportion of sugar beet top silage normally made in this area.

Type of Fermentation Each sample of silage received was accompanied by a report on the efficiency of the making process, and was further assessed in the laboratory. The types of fermentation were distributed as follows:

	per cent
Well-made or satisfactory	82.3
Underheated	2.2
Slightly overheated	8.1
Overheated	5.9
Mouldy or putrefying	1.5

The percentage of samples that were slightly or badly overheated was much higher than that for the Province as a whole, but it must be remembered that in carrying out the survey the samplers attempted to get *every* silo sampled, so that materials which normally do not find their way to the laboratory were examined to complete the records. Despite this, practically

90 per cent of the total silage was in fair-to-good condition from the fermentation aspect, and, where the poorer types of silage were met with, Advisory Officers did very useful educational work by pointing out where the faults in making had occurred and how they could be avoided in future.

Quality Evaluation All silage received was analysed for dry matter content, *p*H values (acidity), and crude protein content of the dry matter. The conventional system of classifying the silage on the protein basis was then followed, protein values above 15 per cent being taken as high, 12-14.9 per cent as medium, and below 12 per cent as low. Where marked overheating of the silage had occurred, resulting in lowered digestibility of the protein, such materials were classed as low, irrespective of their actual analysis.

Distribution of Protein Quality

	per cent
High	39.8
Medium	35.3
Low	21.3
Low through overheating	2.9
Mouldy	0.7

Thus practically 40 per cent of the silage made in Hertfordshire in 1948 was sufficiently high to be assessed as balanced for milk production, and less than 25 per cent was suitable for maintenance purposes only. If one takes the figure of 7,000 tons of silage made in the county and assumes an average dry matter content of 21 per cent, this high percentage of best quality silage was equivalent in milk production nutrients to practically 300,000 gallons of milk, or over 500 tons of balanced cake. This figure does not take into account the partial cake-substitution value of the medium protein silage. These figures illustrate the increasing part that silage is playing in the feeding-stuffs economy of dairy cows during the winter months.

Dry Matter and Acidity Values For record purposes and from the point of view of general interest, the distribution of the figures obtained for dry matter and *p*H values (acidity) are also given. Over 60 per cent of the silages received had dry matter contents ranging from 15 to 23 per cent ; outside this range the silage was either obviously very wet, with the moisture readily expressed by gentle squeezing, or else rather dry so that moisture could not be squeezed out except with considerable difficulty. The mean value for all the dry matter figures was very close to 21 per cent, and at this figure for a well-made, high protein silage 20-25 lb. of the silage would provide sufficient nutrients for the production of a gallon of milk.

Dry Matter	Distribution	*p*H Value	Distribution
per cent	*per cent*		*per cent*
Under 15	3.7	Under 3.6	3.7
15.1 to 19	26.4	3·6 to 3.9	16.2
19.1 to 23	34.0	4.0 to 4.5	23.5
23.1 to 27	21.3	4.6 to 5.1	28.0
27.1 to 31	11.7	5.2 to 5.7	21.2
Above 31	2.9	Above 5.7	7.4

The *p*H figures are also interesting in that nearly 60 per cent of the values lay above *p*H 4.5. It is still held by some authorities that a *p*H figure exceeding 4.5 is indicative of a butyric type of fermentation, and values above 5.0 are said to suggest a definitely underheated silage and faulty making. In our experience, although these limiting values appear to be true

for oat-and-tare silage, we are reluctant to believe they are applicable to all types of silage. With the high protein types of silage from predominantly clover types of ley, and particularly with lucerne mixtures, it is extremely rare to get a *p*H value of under 4.6, and not often does the value fall below 5.0. In fact, with most lucerne types of silage (and 25 per cent of the silage made in East Anglia is of these types), which are almost invariably molassed liberally when made, it is unusual to get a *p*H figure of less than 4.9, and the general run is from *p*H 5.0 to 5.4. Above this value the odour of silage is very strong and cheese-like, and the butyric acid becomes more pronounced as the *p*H value increases.

We do not think that it is possible to specify the type of fermentation from a determination of the *p*H value alone; the figure has to be taken into consideration with the type of crop from which the silage is made. It is obvious that a good deal more fundamental work is necessary with these predominantly leguminous types of silage, and since in the eastern counties protein foods are scarce, most farmers are taking to ensilage as a means of conserving material of as high quality as possible.

In ensiling such crops as young clover and lucerne, it is necessary to be liberal with molasses, and a minimum allowance of two gallons, suitably diluted, is essential for the fermentation to be reasonably satisfactory, particularly when the crops are very sappy and have not yet reached the flowering stage. Our experience suggests that it is possible to begin ensiling a leguminous crop at too early a stage of growth, especially early in the season, and, contrary to the general advice for most types of silage, excessive consolidation of very young material should be avoided.

It should be pointed out that the silage examined in the county survey reported upon here was made in all types of silo—tower, pre-cast concrete, clamp, pit and stack. Provided the rules of good silage-making are followed, the type of silo appears to be immaterial; the emphasis is upon what is available and what is practicable on each individual farm. We do seem to have experienced a higher proportion of waste in the sectional concrete types of silo, where no attempt had been made to exclude air at the sides by sealing the joints in the concrete, and owing to the tendency of all silage to settle, it is often very difficult to make an effective protection against the weather and against waste at the top of the silo as the material settles down. Moreover, as in 1948 there was a cool, wet summer, on the whole stack silage appears to have been less prone to overheating than in the hot, dry summer of 1947.

The Hertfordshire survey has shown that not only is silage-making on the increase, but that higher feeding quality silage is being made. From the educational aspect satisfactory reports, not only analytically, but in the form of practical results obtained with livestock and in milk production, have encouraged farmers to go ahead with plans for more silage; adverse reports have been accompanied by suggestions of how to avoid obvious errors in future. The enthusiasm of the county staff and the ready co-operation of the farmers have contributed very materially to securing the information given in this article. The growing realization of the part that silage is playing and can play is helping towards greater self-sufficiency on our farms, and hence silage is making a very valuable contribution to the national economy in the difficult times through which we are at present passing.

PIG-FEEDING TRIALS AT WYE WITH FODDER BEET

INTERIM REPORT

A. C. DUNKIN, B.Sc. (Agric.) and Professor M. M. COOPER
Wye College

THE physiological limitation of a simple stomach of comparatively small capacity prevents the pig from making efficient use of a ration containing a high proportion of very watery foods. Thus root crops such as mangolds and swedes, with a dry matter content of 9.13 per cent, while useful particularly in limited quantities for breeding stock, are unsuitable for pig feeding on a heavy scale. Potatoes, sugar beet and certain varieties of fodder beet, on the other hand, are approximately twice as concentrated, having a dry matter content varying from 19 to 24 per cent. While, however, potatoes are generally acknowledged as an excellent fattening food, the beets, with a dry matter content only slightly less than that of potatoes and with a similar low fibre content, have been far less widely used for pig feeding. On the basis of yield of food nutrients per acre, which is becoming an increasingly important yardstick, a 19-ton crop of fodder beet of 20 per cent dry matter yields twice as much dry matter per acre as an 8-ton crop of potatoes and is equivalent in this respect to a 29-ton mangold crop of 13 per cent dry matter.

In contrast to mangolds, which require a storage period to complete maturation, roots of the sugar beet type can be pulled and fed direct ; so that by early sowing a constant supply of beet may be available from September onwards. The value of the tops in early autumn is considerable, and when the whole plant is fed at this time, it helps to narrow the overall nutritive ratio by reason of a higher protein content.

So much for the theoretical advantages of the high dry matter beets which, together with the encouraging results of some New Zealand feeding trials with sugar beet (1), led us to start a series of trials with fodder beet at Wye in 1947-48. In parenthesis it should be emphasized that the following trials relate only to a high dry matter fodder beet, since very appreciable varietal differences in respect of dry matter content occur, some varieties of fodder beet having a dry matter content comparable only with that of mangolds.

Following a small-scale plot experiment in that year, using beet of the Danish variety Hunsballe, further trials were carried out in 1948-49 with this same variety. Table 1 gives details of root and dry matter yields obtained, and for comparison, the corresponding figures relating to a four-year series of Danish trials recently reported are also included (2).

Table 1. Crop Yields of Hunsballe Beet

	Roots *tons per acre*	D.M. Content *per cent*	Dry Matter *tons per acre*
Wye 1947	22.2	20.6	4.56
Wye 1948	18.8	20.0	3.76
Danish trials	19.7	20.3	4.00

1947-48 Trial Using Large White and Large White × Essex stores of 120-125 lb., five lots of litter mates paired for sex and weight were allocated to two treatments :

Treatment I. Control. All meal feeding, according to the scale given below.

Treatment II. 3 lb. per head daily of a basic meal mixture containing 20 per cent fishmeal, plus fingered beet to appetite.

Meal Mixtures

	Treatment I	Treatment II
Barley meal	65	60
Fine millers' offals	30	20
White fishmeal	5	20
	100	100

Feed Scales—Control Pigs

100 lb. live weight	5 lb. meal
140 ,, ,, ,,	6 ,, ,,
160 ,, ,, ,,	$6\frac{1}{2}$,, ,,
180 ,, ,, ,,	7 ,, ,,
200 ,, ,, ,,	$7\frac{1}{2}$,, ,,

Pigs were fed individually and weighed weekly. During a preliminary four-week period the meal allowance of the beet pigs was gradually reduced to 3 lb. as beet consumption rose; at the same time, the fishmeal content of the meal mixture was gradually increased from an initial 5 per cent to 20 per cent. In this way an attempt was made to balance the intake of total nutrients by both groups, the deviation in weight between pairs at the close of this preliminary period indicating the extent to which this was successful. For a similar reason, the controls' meal allowance was increased to a maximum of $7\frac{1}{2}$ lb. at 200 lb. From the third week and throughout the six-week experimental period it was necessary to adopt three times daily feeding, since daily beet intake rose to a maximum of 20 lb. From a weighed day's supply, approximately one-third of the meal and beet allowances were mixed together with a little water at each meal. On Sundays only two feeds were given, amounting to two-thirds of a normal day's ration.

Table 2. Liveweight Gains (lb.)

Block	Initial Live Weight		Final Live Weight		Total Gain		Average Daily Gain	
	Treatment I	II	Treatment I	II	Treatment I	II	Treatment I	II
1	147	144	209	206	62	62	1.51	1.51
2	151	152	207	209	56	57	1.37	1.39
3	151	149	211	211	60	62	1.46	1.51
4	164	159	209	211	45	52	1.10	1.27
5	169	169	233	220	64	51	1.56	1.24
Mean	156.4	154.6	213.8	211.4	57.4	56.8	1.40	1.39

Table 3. Food Consumption and Economy of Gains (lb.)

Block	Total Meal		Total Beet		Meal per 1 lb. Gain		Beet per 1 lb. Gain	
	Treatment I	II	Treatment I	II	Treatment I	II	Treatment I	II
1	263	117	—	694	4.24	1.89	—	11.2
2	263	117	—	708	4.70	2.05	—	12.4
3	263	117	—	712	4.38	1.89	—	11.5
4	270	117	—	691	5.99	2.25	—	13.3
5	277	117	—	694	4.32	2.30	—	13.6
Mean	267.2	117	—	699.8	4.65	2.06	—	12.31

Treatment II pigs took to the beet very readily and appeared to find it highly appetizing, no refusals being recorded during the 41 days of the trial period, though a considerable time was required to clear up the large amounts of beet offered, each meal lasting an average of 40 minutes and up to an hour in some cases. Both groups remained in good health throughout the trial and, although the dung of the beet-fed pigs was softer and persistently darker in colour than that of the controls, no scouring occurred. At the end of the trial the controls appeared to carry rather more bloom.

Liveweight gains for both groups were very satisfactory, with a difference in total gain for the two groups of only 3 lb. This difference was not significant at the 1 per cent point. Food consumption figures indicate that an average intake of 6¼ cwt. of beet saved 150 lb. of meal, giving a meal equivalent value for beet of 4.7 lb., and representing an economy of 56 per cent on the amount of meal eaten by the control pigs.

Carcass measurements on 8 pigs failed to disclose any treatment difference in respect of backfat or belly thickness, while firmness of fat was equally good in both groups.

1948-49 Trials:
I. Individual Feeding Experiment

A further trial took place from December, 1948, to April, 1949, in which the two previous treatments were repeated (No. I and II below). In addition, since 20 per cent fishmeal in the basic meal appeared an adequate upper limit, and in view of Woodman's conclusions regarding the adequacy of a meal containing 10 per cent fishmeal fed in conjunction with steamed potatoes (3), a third treatment was added in which 3 lb. of meal mixture containing only 10 per cent fishmeal were fed together with beet to appetite.

All pigs were Large Whites of about 95 lb. at the outset, comprising five blocks each of three litter-mates. Random allocation of pigs within blocks to the three treatments gave an experiment of randomized block design with five replications. Feeding scale, meal mixtures I and II, and food preparations were similar in all details to those of the previous trial. Whereas, however, in the 1947-48 trial pigs had been housed in covered sties with small open yards, each accommodating five pigs, in the second trial all the pigs were housed together in an open yard, with covered sleeping quarters and equipped with individual bails for feeding. After a preliminary period similar to that of the previous trial the experiment ran for ten weeks, with three times daily feeding starting at the end of the preliminary period.

Table 4. Liveweight Gains (lb.)

Block	Initial Live Weight			Final Live Weight			Total Gain			Average Daily Gain		
	Treatment I	II	III	Treatment I	II	III	Treatment I	II	III	Treatment I	II	III
1	140	137	133	232	235	214	92	98	81	1.31	1.40	1.16
2	138	139	135	229	217	210	91	78	75	1.30	1.11	1.07
3	125	126	124	217	220	185	92	94	61	1.31	1.34	0.87
4	127	127	110	221	218	181	94	91	71	1.34	1.30	1.01
5	124	126	124	210	217	206	86	91	82	1.23	1.30	1.17
Mean	130.8	131.0	125.2	221.8	221.4	199.2	91.0	90.4	74.0	1.30	1.29	1.06

Table 5. Food Consumption and Economy of Gains (lb.)

Block	Total Meal			Total Beet			Meal per 1 lb. Gain			Beet per 1 lb. Gain		
	Treatment I	II	III	Treatment I	II	III	Treatment I	II	III	Treatment I	II	III
1	445	195	195	—	1152	1085	4.84	1.99	2.41	—	11.75	13.39
2	444	195	195	—	970	1035	4.88	2.50	2.60	—	12.44	13.80
3	422	195	195	—	1062	815	4.58	2.07	3.20	—	11.29	13.36
4	434	195	195	—	1006	893	4.62	2.14	2.75	—	11.06	12.58
5	426	195	195	—	990	1001	4.96	2.14	2.38	—	10.88	12.21
Mean	434.2	195	195	—	1036	965.8	4.77	2.16	2.64	—	11.46	13.05

It will be observed that the general performance of pigs in this second trial was slightly inferior to those in the 1947-48 trial. This might be at least partly accounted for by the more exposed nature of the accommodation and the greater freedom of movement in the second trial. The results of Treatments I and II were again in very close agreement however. Differences in gains between Groups I and II were not significant at the 1 per cent point, but both were significantly greater than Group III.

Beet consumption by pigs in Blocks 3 and 4 of Treatment III was subnormal even during the preliminary period, but, in general, daily gains for this group are seen to be appreciably less than for the others. In addition to these two pigs, Block 2 of Treatment II was consistently below the average in rate of beet consumption and, although this again reached a maximum of 17½-21 lb. daily, the appetite of the beet pigs appeared to be exceeded more easily than was the case in the first trial, while the overall incidence of food refusals was much higher. Scouring was observed in certain of the beet pigs from time to time, especially in the three pigs already mentioned, but it was not sustained, except for Treatment III pigs in Blocks 3 and 4.

A comparison of food consumption figures for Groups I and II reveals that a saving of 55 per cent of meal was achieved over the ten week period by the feeding of 9¼ cwt. of beet, representing a meal equivalent value for beet of 4.33 lb. The significantly lower performance of Group III precludes a similar comparison.

II. Group Feeding In order to obtain information as to the practicability of using fodder beet for fattening under commercial conditions, five groups, each containing five baconers of 120-135 lb., received uncleaned beet that had been roughly chopped with a spade, in place of part of their meal allowance for a period of nine weeks. No attempt was made to feed beet as heavily as in the individual feeding trials, the beet being given alone at midday and followed by a reduced meal feed in the afternoon. The replacement ratio used was 5 lb. uncleaned beet to 1 lb. meal. Starting at 10 lb. per group daily, the beet allowance was increased gradually to 40 lb. after five weeks. A similar meal mixture to the one used for the control group in the previous experiments (i.e., containing 5 per cent fishmeal) was used throughout.

Table 6. Summary of Results (lb.)

	Group (5 pigs each)					Average
	I	II	III	IV	V	
Total initial weight	695	587	603	720	683	657.6
Total final weight	1083	1005	988	1126	1090	1058.4
Total gain (9 weeks)	388	418	385	406	407	400.8
Average daily gain per pig	1.23	1.32	1.22	1.29	1.29	1.27
Meal consumption	2008	1866	1866	1976	1957	1934.6
Beet ,,	1732	1689	1732	1732	1732	1723.4
Estimated percentage saving in meal	18.8	18.6	19.9	16.7	18.7	18.5

Liveweight gains were moderately good, though slightly less than might have been expected on all-meal feeding. Performance, however, was in close agreement with those pens of meal-fed baconers of approximately the same initial weight.

Discussion of Results The results of these first two series of trials, in failing to disclose any significant difference in length of fattening period when half the dry matter of the ration was provided by beet, fed in conjunction with a high protein basic meal, suggest the useful contribution which high dry matter beet is capable of making to our supplies of home-grown starchy foods suitable for pigs. Rather poorer results, including a wider meal replacement ratio, have been reported in similar Danish trials with sugar beet ([4]), but the initial live weight in these tests was 65-75 lb., compared with weights of 125 and 95 lb. respectively in the trials here reported. Incomplete data on a number of beet fed pigs maintained on the experimental treatments until 250 lb. indicate some falling off in rate of gain after about 220-230 lb. From this fragmentary evidence, together with the Danish results, it seems that normal fattening can be expected only with heavy beet feeding over a limited weight range, and that care must be taken over the gradual introduction of beet into the ration.

As regards the minimum level of protein necessary for rapid growth and fattening, Treatment III of the 1948–49 trial has supplied little information on this point, since the poor growth of two pigs, almost from the outset, cannot definitely be attributed to the lower fishmeal content of their ration. In view of a maximum daily gain of only 1.17 lb. in this group, however, it does appear that the 10 per cent fishmeal level is barely adequate. While stressing the need for further investigation, preliminary results suggest that the minimum level of fishmeal for normal growth lies between 10 and 20 per cent.

Economic Considerations. Of prime interest to the practical man is the comparative cost of beet feeding in relation to the cost of other available foods. Wyllie, in a report on production costs and financial results for root crops ([5]), draws attention to the very wide variation in cost per ton of roots, especially mangolds, both between individual farms and from season to season. He emphasizes the futility of employing average results in trying to decide whether a particular crop is worth growing. Applying this principle to the growing of fodder beet, it is clear that its economic feasibility is primarily determined by the cost per acre for which any farmer can grow fodder beet and by the yield per acre he can reasonably expect

to obtain over a number of years. It is suggested, however, that provided a combination of these factors enables beet to be grown and stored for an overall cost per ton slightly less than the current price for stock-feed potatoes, then total feeding costs will compare favourably with those for potatoes, since the poorer meal replacement value of beet is practically offset by the additional cost involved in steaming potatoes.

Without attempting to minimize the very real value of potatoes for pig feeding, it is pointed out that the crop is subject to heavy seasonal fluctuations in yield. In such circumstances the farmer growing only a small acreage of potatoes, but who is also fattening pigs, might conceivably find a small acreage of fodder beet a useful insurance.

It appears that fodder beet has appreciable commercial possibilities, as an alternative to potatoes in individual cases where the latter are unsuitable or, in general, when supplies and prices of potatoes for stock-feeding are unfavourable.

Perhaps the greatest application of fodder beet feeding, however, will prove to be for pregnant and growing breeding stock, especially when yarded or run out on pasture. So far this important aspect has not been tackled, but now, having obtained some indication of the feeding value of beet for fattening pigs, it is hoped to gain experience of its use with breeding gilts and sows, in addition to acquiring further information as to the optimum protein level of the ration and the economics of beet feeding to various classes of pigs.

References

1. Cooper, M. M. Sugar Beet Trials with Pigs. *New Zealand J. Agr.* (1941), **62**, 3, 173.
2. Beet for Fodder. *Farmer and Stock-Breeder* (1949), **63**, 3120, 1900.
3. Woodman, H. E. and Evans, R. E., *J. Agr. Sc.* (1943), **33**, 155-68.
4. Jespersen, J., *Forsøgslab. København Beretn.* (1945), 214, 127. Abstract in *Nut. A. and R.* (1947), **17**, 2, 539.
5. Wyllie, J. Costs of Production and Financial Results for Potatoes, Sugar Beet, Mangels and Kale, 1939 to 1945. *Wye College Dept. of Economics Report No.* **40**.

FODDER BEET FOR FATTENING PIGS

COMPARISON WITH MANGOLDS

R. Braude, Ph.D. and K. G. Mitchell, B.Sc.

National Institute for Research in Dairying, Shinfield, Reading

An experiment was carried out at the National Institute for Research in Dairying for the purpose of providing a live pigs exhibit at the Royal Counties Show at Sonning in June, 1949. The objects of the exhibit were to demonstrate that home-grown roots could be used successfully in the ration of fattening pigs with a considerable saving of meal, and to compare the value of fodder beet, a root crop only recently introduced into this country, with mangolds. The exhibit aroused great interest, and it was decided to make a full report of the experiment.

The shortage of meal available for pig feeding during and since the war has made the inclusion of other types of foods in the ration of the pig a necessity for the majority of pig-keepers. Such bulky foods as mangolds, potatoes and swill have been widely used for this purpose. Provided these are fed in conjunction with a small quantity of a properly balanced meal, satisfactory results can be obtained. The complete ration must not only

provide protein, carbohydrates, minerals and vitamins in amounts needed by the pig, but also its bulk must be limited so as to allow the pig, with its comparatively small stomach, to consume and digest sufficient to cover its nutritive requirements. A method of feeding these bulky foods in general use is called the Lehmann system, which consists of feeding a small, fixed quantity of meal throughout the fattening period, supplemented by the available bulky foods fed according to appetite.

Experimental The experiment was designed to show the importance of using a correct basal meal and, at the same time, to compare the value of fodder beet with that of mangolds as the supplementary food. The Lehmann system of feeding was used, the experimental pigs being given 2½ lb. daily of a basal meal throughout the fattening period, plus the supplementary food fed according to appetite. Control pigs received an all-meal ration.

Table 1. Composition of Meals Used

	Meal Mixture A	Meal Mixture B	Meal Mixture C
Wheat offals	30	28	28
Barley meal	35	35	44
Crushed tail-wheat	–	20	20
Flaked maize	23	–	–
Dried grass	2	2	–
Fishmeal	10	15	–
Meat and bone meal	–	–	5
Decorticated groundnut cake	–	–	3
Cod liver oil	*	*	–
Percentage crude protein	16.3	19.7	13.4
Approximate price per cwt.	25s. 6d.	26s.	23s. 3d.

*Approximately 30 g. per pig added once weekly directly into the troughs.

There were four treatments, and six pigs were placed at random on each treatment. A single experimental unit consisted of four pigs as similar as possible at the beginning of the experiment. As twenty-four home-bred Large White weaners (11-13 weeks old) from three litters were all available at one time, each group of six pigs receiving the same treatment were placed together in a large pen which contained six small pens for individual feeding. The pigs were shut into these individual pens at feeding time and were let out together in the large pen for the remainder of the day and night.

The pigs were weighed weekly throughout the experiment, and an estimate of any food refused was made daily for each pig. The experiment was started on February 21, 1949, and continued for 17 weeks.

The varieties of the roots used were Intermediate Red mangolds and Danish fodder—sugar beet, White Øtofte. The mangolds contained 9.1 per cent and the fodder beet 21.3 per cent dry matter. The meal mixtures used in the experiment are given in Table 1. Sufficient quantities of them were mixed before the experiment was started to last for the whole experimental period. The four experimental treatments were as follows:

PEN. 1. Controls. The six pigs in this pen received Meal A throughout, the quantity given being based on live weight and a scale for fattening pigs (cf. Braude and Foot; 1942). The meal was fed twice daily as a wet mash, 3 lb. of water being allowed for each 1 lb. of meal.

PEN 2. The pigs in this pen received Meal C as a wet mash, on the same scale as the control pigs, until at 50 lb. live weight each pig was receiving 2½ lb. daily. This quantity of meal was then kept constant, and raw, sliced mangolds were introduced, the amount given being adjusted according to appetite. Six pints of water were added per day to allow for the 2½ lb. of meal in the ration.

PEN 3. The pigs in this pen received Meal B, otherwise they had the same treatment throughout as those in Pen 2.

PEN 4. Meal B was also given to the pigs in this pen in the same manner as for the pigs in Pen 3, but in place of mangolds, raw, sliced fodder beet were given.

The pigs in Pens 2, 3 and 4 were fed twice daily until they had been receiving the roots for about 10 weeks. By then appreciable quantities were being consumed and it was decided to feed three times a day—at 7.30 a.m., 11.45 a.m. and 4.0 p.m.

At the end of the experimental period (June 20) the average daily consumption of roots per pig was as follows:

Pen 2	24.0 lb.	mangolds
Pen 3	28.9 ,,	,,
Pen 4	18.3 ,,	fodder beet

With these large quantities of roots, the pigs took twice or three times as long as the control pigs to eat their food.

Results and Discussion All the pigs on test, with one exception, were in good health throughout the experimental period, and within each group they grew at a consistent rate. Pigs receiving a large proportion of roots in their diet had very soft dung, and this was more pronounced in the pigs which received mangolds than with those receiving fodder beet. During the week beginning May 9, one pig in Pen 2 was observed to be unwell and was refusing food. It appeared to have difficulty in walking and would not get up unless forced to do so. It lost 18 lb. in weight in the course of a few days and had to be excluded from the experiment. It is, however, of interest that after only a week on a good all-meal diet, supplemented with cod liver oil, the pig recovered and thereafter made normal growth. It is thus possible that the cause of the trouble was vitamin A deficiency.

The results of the experiment are summarized in Table 2 and in the diagram, the latter showing the mean growth curves for pigs in each group.

Comparison of the results for pigs in Pens 2 and 3 shows that the rate of growth and the efficiency of food utilization of the pigs in Pen 3 were significantly better than those of the pigs in Pen 2. Since both lots of pigs received mangolds as the supplementary food, the differences recorded were obviously due to the different basal meals fed. Basal Meal B received by the pigs in Pen 3 was designed to provide all the nutrient required for normal growth when fed in conjunction with the supplementary food, whereas no such attempt was made in respect of basal Meal C received by the pigs in Pen 2. The complete ration of the latter was deficient in protein, at least in the early stages of the experimental period, and also deficient in some minerals and vitamins. These results demonstrate the importance of ensuring that the basal meal fed with the roots on the Lehmann system is properly compounded to supply all the required nutrients.

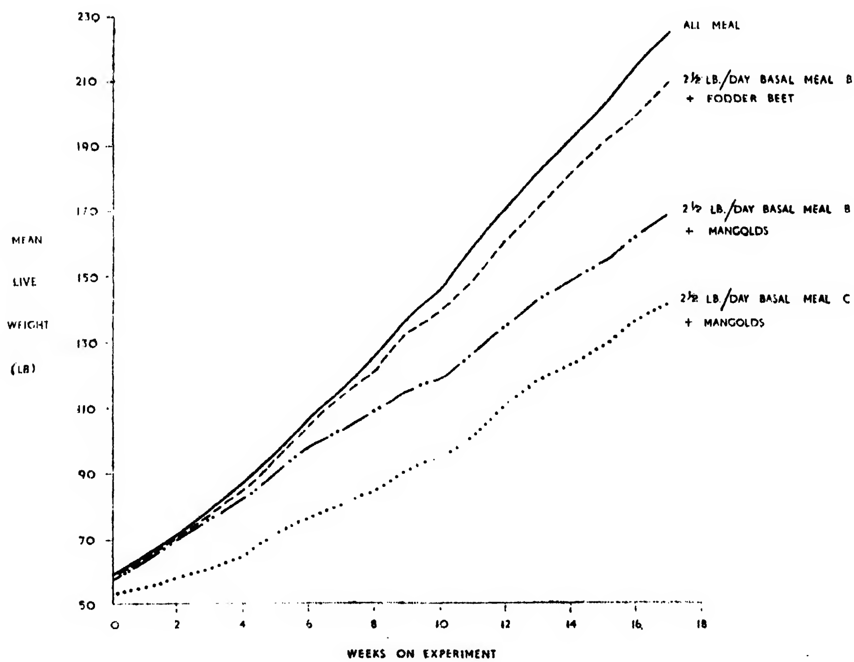
By comparing results for the pigs in Pens 3 and 4, both of which received the good basal Meal B, the value of fodder beet, as against mangolds as the bulky supplementary food, is demonstrated. The rate of growth and the efficiency of food utilization of the pigs receiving the fodder beet were greatly superior to those of the pigs receiving mangolds.

It has already been mentioned that the dry matter content of the fodder beet was more than double that of the mangolds (21.3 per cent as against 9.1). As analyses have shown, this difference in dry matter is due mainly to the percentage of soluble carbohydrates of which a considerable proportion (up to 85 per cent) in the fodder beet is present as sugar. Although this high sugar content probably accounts for part of the superiority of the

Table 2. Average Liveweight Gain and Food Consumption Figures for the Four Experimental Groups

MEAN WEIGHT *lb.*	PEN 1 All meal (Control)	PEN 2* 2½ lb. per day basal Meal C +Mangolds	PEN 3 2½ lb. per day basal Meal B +Mangolds	PEN 4 2½ lb. per day basal Meal B +Fodder Beet
Initial	58.8	53.2	58.7	58.3
After 119 days	224.0	142.0	169.2	209.7
Gain	165.2	88.8	110.5	151.3
Daily gain	1.39	0.75	0.93	1.27
Meal consumed per lb. liveweight gain	3.58	3.35	2·69	1.97
Roots consumed per lb. liveweight gain	–	13.85	16.21	9.00

*The figures for Pen 2 are the mean of five pigs only—see p. 371.



Mean growth curves for pigs receiving the four experimental treatments.

fodder beet, there can be no doubt that the lower moisture content, and hence reduced bulkiness of the beet, was a major factor responsible for the better growth of the pigs in Pen 4. The pigs receiving the fodder beet as supplement were able to consume quite comfortably a sufficient quantity of them to supply enough dry matter and nutrients required for normal growth. On the other hand, it will be seen from the diagram opposite that when pigs receiving the mangolds reached about 100 lb. live weight they were unable to consume enough dry matter from mangolds to satisfy their requirements, owing to their rather limited stomach capacity, and accordingly their rate of growth gradually declined.

These results provide a striking demonstration of the importance of limiting the bulkiness of the ration fed to the pig. Failure to do so results in a considerably slower rate of growth and a very much lowered efficiency of food utilization. Some years ago Braude and Foot (1942),* using the Lehmann system of feeding, obtained much better results with mangolds as the supplementary food by mixing them with biscuit waste (6 parts of mangolds to 1 part of biscuit waste). This had the effect of lowering the bulkiness of the complete ration with the consequent better results. A similar effect could be obtained by increasing the amount of the basal meal fed daily from 2½ to 3½ lb. per head. Alternatively, the addition of 1 lb. per pig daily of home-grown ground grain (e.g., barley, oats, tail-wheat) would help to reduce the bulkiness of the ration containing mangolds.

The value of fodder beet as the supplementary food to a good basal meal on the Lehmann system can be judged further by a comparison of the results for the pigs in Pen 4 with those for the control pigs in Pen 1, which received a good all-meal diet. The figures in Table 2 show that the mean liveweight gain of the control pigs during the whole experimental period was 13.9 lb. greater than that of the pigs receiving the fodder beet. As regards food utilization, the pigs in Pen 4 consumed on the average 1.61 lb. of meal less for each 1 lb. liveweight gain than the controls, but in addition to the meal consumed 9.0 lb. of fodder beet for each 1 lb. of gain. To make a more direct comparison, the mean dry matter consumption per 1 lb. liveweight gain has been calculated: pigs in Pen 1 consumed 3.12 lb. while those in Pen 4 consumed 3.63 lb. of dry matter for each 1 lb. liveweight gain. The control pigs were therefore rather more efficient in the use of dry matter than the pigs receiving fodder beet. However, taking into account the additional energy required for mastication and digestion of a very much larger bulk, the results for the fodder beet pigs must be regarded as entirely satisfactory. It is also interesting to compare the two groups on a "meal" basis. The fodder beet consumed by the pigs in Pen 4 may be considered to take the place of the difference in meal consumption between the control pigs and those receiving fodder beet. On this basis it is found that 5.6 lb. of fodder beet are equivalent to 1 lb. of meal.

The real value of the use of fodder beet in the diet of the pig lies in the large saving of meal that it makes possible. Thus the mean total consumption of meal per control pig was 591.9 lb., as against 297.5 lb. for a pig receiving fodder beet, a saving of 294.4 lb. or approximately 50 per cent. It should be borne in mind that at the end of the experimental period the control pigs had gained an average of 13.9 lb. per pig more than those receiving fodder beet. Therefore for a really strict comparison of the saving of meal to be made, the extra ten days or so that would be required for the fodder beet pigs to make the same gain as the control pigs should be taken into

*Braude, R. and Foot, A. S. *J. Agric. Sci.* (1942), **32**, 70.

account. As this would, at the most, mean an extra consumption of only 25 lb. of meal per pig, the saving of meal over the whole fattening period remains very substantial.

In addition to the meal-saving aspect, the financial returns obtained are of great practical importance. Taking current prices for meal and fodder beet at £4 a ton, the average cost of food consumed by each pig in Pens 1 and 4 during the fattening period was £6 14s. 8d. and £5 17s. 11d. respectively. Although the labour costs per pig would be slightly higher for those fed on roots, it is obvious that a reasonable profit would be made for pigs in both groups.

After slaughter the carcasses of the control pigs and of the pigs which received fodder beet were examined by expert graders at the bacon factory and samples of loin fat were sent to Dr. E. H. Callow, of the Low Temperature Research Station, Cambridge, for determination of the Iodine Number. The points allocated by the graders were very similar for the two groups and put all the carcasses in high quality grade. There was some indication, however, that the fat was firmer in the carcasses of pigs which received fodder beet. This was confirmed by the Iodine Numbers, which are given in Table 3. Thus the value of the carcasses for bacon-curing from the fodder-beet-fed pigs was higher than that of the all-meal-fed pigs. The high proportion of flaked maize in the ration of the latter was probably mainly responsible for the softer carcass fat.

Table 3. Iodine Number of Loin Fat

Sample	Control Pigs		Fodder Beet Pigs	
	Outer Layer	Inner Layer	Outer Layer	Inner Layer
1	74.5	62.2	63.5	54.9
2	72.6	62.9	63.5	55.4
3	72.6	63.9	65.3	55.2
4	73.7	63.3	61.4	55.6
5	70.1	57.9	63.4	55.2
6	74.4	65.1	65.4	54.3
Mean	72.98	62.55	63.75	55.10

Summary 1. An individual feeding experiment using twenty-four pigs was carried out with the object of demonstrating that bulky, home-grown roots could be used successfully in the ration of fattening pigs on the Lehmann system, provided they were fed in conjunction with a properly balanced meal.

2. The value of fodder beet as a supplementary food was found to be greatly superior to that of mangolds.

3. The growth rate of pigs which received fodder beet and the efficiency with which they utilized their diet was only slightly inferior to those of pigs which received a whole meal diet. An equally satisfactory profit per pig was obtained on both diets.

4. The quality of the carcasses from the pigs fed fodder-beet was better than that from the pigs fed meal only, the fat of the former being much firmer.

We wish to thank Mr. A. S. Foot, the Head of the Dairy Husbandry Department, for his interest in this experiment, and Dr. E. H. Callow and his colleagues for the determination of the Iodine Numbers. We are also indebted to the Directors of Messrs. M. Venner and Sons, Ltd., Bacon Factory, Reading, and their General Manager, Mr. E. Gunson, for the facilities provided and help given during the slaughter and grading of the experimental carcasses.

FARMING IN THE SHETLANDS

ALLAN FRASER, B.Sc., M.D.
University of Aberdeen

NORTH of Scotland there are two large groups of islands, the Orkneys and the Shetlands; the Fair Isle, "the Island of Sheep," lies half-way between. The Orkneys are within sight of the mainland of Scotland; the Shetlands are a full day's sailing further north. Both groups of islands were for many centuries dependencies of Norway. That is important in the understanding of the place-names, the people, and their agriculture. The place-names are all Norse. There has been no Gaelic spoken in these islands within historical times. The people are of Scandinavian descent and have carried some of the farming energy of Scandinavian peoples with them across the seas. That farming energy is more obvious in Orkney than in Shetland, simply because the soil of the Orkneys is much more suitable for agriculture. The land of much of the Orkneys is good, deep, productive land, responsive to high farming. By contrast, Shetland is barren, rocky, and less profitable to farm. Both groups of islands are deeply indented by the encircling sea, rich in sea-harvest. In both, the claims of fishing have clashed with agriculture, for no man can fish the sea and till the land in the same season. In the Orkneys the claims of the land have prevailed. In the Shetlands the call of the sea has conquered. That fact has nothing to do with any difference of race or culture of the peoples: it is due to the great superiority of farming opportunities which the Orkneys provide. Consequently it has become a common saying in Scotland that while the Orcadian is a farmer with a fishing boat, a Shetlander is a fisherman with a croft. That definition requires some modification in modern times. Many men of Shetland have abandoned their crofts and go to sea in deep-sea craft rather than in fishing boats.

Crofting in Decline In the long strip of sea-bitten land called the mainland of Shetland, in the northernmost islands of Yell, Fetlar, and Unst, there is of course much farming land, with innumerable crofts. Already, however, many crofts have been abandoned, as many, perhaps, as there are crofts remaining in cultivation.

J. Peterson, in his beautifully illustrated book *Shetland: A Photographer's Notebook** published last year, writes: "The future of Shetland crofting is the islands' biggest problem."

That is true not only of Shetland, but of all the remote islands off the coasts of Scotland. The croft, surrounded by sentiment, sheltered by legislation, idealized by those who do not live on them, is nevertheless a dying form of agriculture. It is a survival, like the platypus. Its eventual extinction will be regretted, for in its own way it was a beautiful thing. So also was the Large Copper Butterfly of the English fenlands—but it went. The materialism of the age is swiftly killing the croft. Again to quote Peterson, "The croft has ceased to be in itself an adequate means of livelihood".

In other words, an able man—and most Shetlanders are able men—is no longer willing to remain in poetic poverty merely for the sake of being photographed. There is often more money to be made out of the photographs than out of the crofts. Those who wish to see the poetic anachronisms of Shetland life—the yoked bullock, the tethered cow, the busily knitting woman leading a lamb to grazing, cereal culture on a "pocket-handkerchief" field, ponies with peat creels on their backs—they should go there quickly

*Lindsay Drummond, 12s. 6d.

now—because the days of these fine things are numbered. The real economic difficulty of crofting, such as Shetland knew it, is that the croft fails to support a modern standard of living for a modern family. Consequently, the members of a crofting family must become wage-earners as well. The modern wage makes the profit, if any, off a croft seem trivial, consequently the croft becomes neglected. What was once a miniature farm becomes a wilderness, the croft-house a dormitory and then a ruin, while the crofter emigrates, becomes a town-dweller, or (if agriculturally ambitious) migrates to districts of Scotland where the soil is more bountiful and the climate kinder.

The agricultural future of the Shetlands would seem to lie not in crofting, but in stock. The livestock of Shetland is both valuable and peculiar. Shetlanders themselves were somewhat slow to realize the value of their stock, and the islands were at no very distant date a happy hunting ground for enterprising dealers from the mainland of Scotland. That is less true today, since, while the costs of travel have heightened, the simplicity of the Shetland crofter has decreased.

Increased Importance of Sheep The Shetlands' livestock riches lie in sheep, cattle and ponies. Contrasted with the Orkneys, no great poultry industry has been developed there. The Shetlands are not suited to produce the grain that hens require. Sheep, on the other hand, have become of progressively greater importance within recent years. Most of the deserted crofting land has been put under sheep. The islands' sheep stocks have increased from 80,613 in 1870 to 213,194 in 1948. Originally, Shetland had a sheep breed all its own, a remnant of the short-tailed, fine-woolled breed once prevalent throughout northern Scotland, the old primitive breed that Frank Osbaldistone noted on his historic ride with Bailie Nichol Jarvie to the Clachan of Aberfoyle:

> Living thing we saw none, except occasionally a few straggling sheep of a strange diversity of colours, as black, bluish, and orange. The sable hue predominated, however, in their faces and legs.

This diversity of colouring persists among the pure-bred Shetland sheep of the present day—

> Unlike the more domesticated breeds, this half-wild animal produces several shades of wool. The more common colours are white and moorit (moor-red), but there are small numbers of other natural shades such as fawns, greys and browns. (*British Pure-bred Sheep*, p. 62).

The Shetland Flock Book Society was established in 1926, in a brave effort to maintain purity in the breed. Such an effort was overdue, for the Shetland breed of sheep was rapidly being "improved" out of existence. Rams of the two main Scottish sheep breeds, Blackface and Cheviot, have been imported in numbers to the Shetlands over many years, to cross with the native Shetland ewes. An occasional Kerry Hill, Ryeland and rams of other breeds have also found their way there. The result of a somewhat indiscriminate crossing policy is that the native Shetland sheep, as a commercial animal and in its pristine purity, has almost disappeared, and that a large proportion of the islands' sheep stock is frankly mongrel. To a sheep-man some of these crosses seem more sensible than others. One of the most valuable qualities of the original Shetland sheep was the fine quality of its wool. Real Shetland wool is a beautiful article to handle. To mix this with the coarse carpet fleece of the Blackface seems somewhat of a textile desecration. The Cheviot, which itself bears a fleece of considerable textile quality, would appear to be a much more suitable cross with the Shetland. Of course, as with all attempts to "improve" primitive breeds

Shetland, looking south from Weisdale

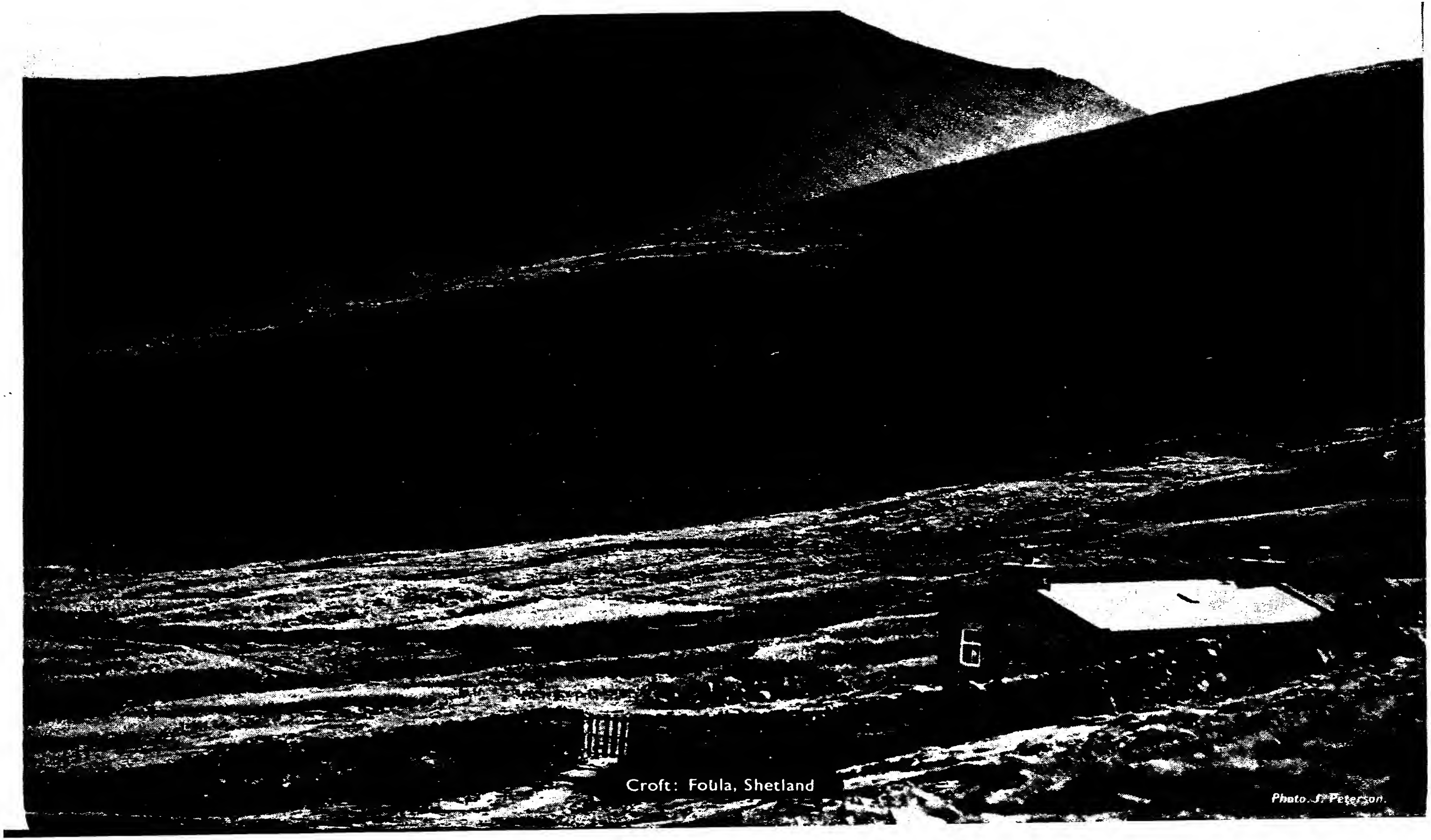

Croft: Foula, Shetland

Photo. J. Peterson.

Crofts: Fogrigarth, Shetland

OBSERVATIONS ON LUCERNE (See pp. 357-9)

of livestock, there has been a curious confusion of thought. Undoubtedly a cross, say, between a pure Shetland ewe and a pure Cheviot ram, will give a valuable first-cross, a better and weightier carcass than that of the pure Shetland, a fleece of sufficiently greater weight to compensate for a certain loss of fineness in the quality. There is also the undoubted advantage of hybrid vigour in the first-cross. Yet if the practice of crossing is repeated indefinitely, there will finally be no original and primitive breed with which to cross. The reservoir, continuously drained, will soon run dry.

Again, the Shetland sheep was the basis of the Shetland textile industry. Shetland shawls and Shetland hosiery gained their reputation on the fine fleece produced by Shetland sheep and the skilful knitting of the Shetland women. Unfortunately, as in the case of so many Highland and Islands industries, production is liable to outrun resources, and reputation come to depend upon the flimsy scaffolding of legend. In plain fact there is—largely because of indiscriminate and somewhat ill-advised crossing—no longer sufficient pure Shetland wool available to support any large-scale industry in native textiles. Goods manufactured from Cheviot wool on a knitting machine are not the same article as those made by handcraft from fine, soft Shetland wool. Mere geographical situation and island atmosphere perform no textile miracles.

Decline in Cattle Modern Shetland cattle, like modern Shetland sheep, tend towards infinite variety. In fact, crossing has gone further, and perhaps today the only true definition of a Shetland cow would be a cow bred in Shetland. When one thinks of the marvellous contribution made by Channel Islands cattle to the dairy industry of the world, it seems a thousand pities that island breeds, like the old Orkney and Shetland, should have suffered such a fate as to become a mere dumping ground for low-priced Scottish mainland bulls. Yet that, in fact, has been their lot. The Shorthorn was followed by the Aberdeen Angus, to be succeeded, when milk became more popular, by the Ayrshire and the Friesian.

Cattle, of any kind, are of less importance in the Shetlands than they once were. There were 29,861 cattle in the Shetlands in 1870. Today they number little more than 7,000, and were it not for the dairying round about Lerwick there would be fewer still. The decrease in cattle population is correlated with the decay in crofting. In the long, dark winter season of the Shetland Isles, cattle require the shelter and care that crofters can provide. They cannot find a living for themselves as sheep will do. When crofting land becomes derelict, sheep, not cattle, are the stock that follow. The cattle of the Shetlands are tubercle-free.

Pure Ponies Shetland ponies, as contrasted with sheep and cattle—thanks to a physical accident—have remained reasonably pure. The accident consists of the physical impossibility of natural mating between a Clydesdale stallion and a Shetland mare. Otherwise, without doubt, such stallions would have accompanied bulls and rams out of Scotland in the mistaken mission to "improve" those islands' livestock. Artificial insemination makes such mating between horse and pony feasible, but, so far, it has not penetrated to the Shetland Isles.

The original use of the Shetland pony was identical with that of all ponies in North Scotland. Where the only communications were tracks and the only fuel was peats, the pony with its creel was essential to human existence. Roads destroy the usefulness of ponies as pack-animals. More can always be carried, and more swiftly, in a cart. For crofting work far fewer ponies are now required. In fact mechanization is—as in less

remote places—fast replacing any kind of horse labour. There are, today, several hundreds of tractors at work in the Shetland Islands. Indeed the persistence in numbers of the Shetland pony is due to the islands' export trade. At one time there was a good trade for ponies to go down the mines. Since mines, like farming, grow ever more mechanized, pit ponies of any kind may soon become outdated, amid humane approval. Shetland ponies of today are in greater demand as children's mounts, not only in Britain but also in America. So long as nobody attempts to "improve" the breed, in the questionable manner in which the islands' cattle and sheep have been "improved," that demand is likely to continue.

The Shetland pony, by its pygmy size, raises the most fundamental problem in all biology—the problem which appeared to be buried with Lamarck, only to be resurrected by Lysenko. Is the small size of the Shetland pony the result of natural and artificial selection of horses of small stature—small by genetic constitution—or has the nutritional stunting of innumerable generations of the Shetland horse induced an obscure yet parallel effect upon its genes ? To that question today there are two (dogmatic) answers, one on either side of the Iron Curtain.

I wish to acknowledge my indebtedness to Mr. John Jamison, B.Sc. (Agric.), Agricultural Organizer in Shetland, for being so good as to supply me with certain data relating to the islands' agriculture.

The photographs reproduced on pp. i-iii of the art inset are from Mr. J. Peterson's book "Shetland : A Photographer's Notebook" and are included by kind permission of the author and publisher.

PROGRESS IN POTATO GROWING

N. McDermott

University of Nottingham, School of Agriculture

AFTER a century of variable progress, the occasion would appear opportune to review achievement in connection with potatoes, in the hope that younger agricultural advisory officers and growers generally will gain a fuller understanding and appreciation of the present-day position in the trade.

The abstraction "progress" in potato growing is defined as the contribution afforded by breeding and trial, and, furthermore, embracing those aspects concerning trade channels (growers and merchants) and the consumer. The subject-matter is thus dealt with in relation to such sequence.

Potato Breeding In the majority of cases, the private breeder has been the benefactor of the industry in providing new varieties, and few of them have received reward in keeping with the magnitude of their contributions. A hundred years ago, as a result of famine caused by the calamitous Blight attack which swept across Europe, a committee was set up, one of its primary objects being to stimulate potato-

breeding work. Since the inception of potato research in this country, thousands of varieties have been raised, but relatively few have merited the initial outlay involved in introduction.

In the matter of potato breeding, it may be stated that the public to some extent leads the breeder; for a variety to become popular it must embody those qualities preferred by the grower; namely, cropping power, freedom from second-growth, immunity or relative immunity from diseases, good keeping quality, and ease of culture. The variety must create a public demand by its colour, shape, size and eating quality, though the preference of the consumer varies amazingly within this small island.

The late Mr. Donald MacKelvie made a valuable contribution in the field of potato breeding, and his and other breeders' untiring efforts to produce immune varieties to replace those then existing, which were susceptible to Wart Disease, filled the gap made by the emergency which arose after the spread of Wart Disease in Great Britain, and the subsequent scheduling of certain areas under the Wart Disease Order of 1923.

During the past forty years, hundreds of varieties have fallen by the wayside, but, on the other hand, some valuable contributions have been made, such as Majestic and Arran Pilot, and several other well-known kinds. It is a comparatively simple matter to breed varieties immune from Wart Disease, but building up and keeping the stock in a vigorous virus-free condition before handing it over to the trade requires patience, skill, and money. Mr. MacKelvie stated that he was satisfied if he got one out of 10,000 seedlings on the market.

An important development is the scientific breeding of potatoes which is now being carried on by the Scottish Society for Research in Plant Breeding at Edinburgh, and the School of Agriculture, Cambridge. These bodies are working on different lines, and it requires new methods to build into our breeding stock blood hitherto untapped, such as the wild (but not always tuber-bearing) species of Solanums. Their programmes include the breeding of new varieties resistant to Blight and virus diseases, and maybe later on we shall have some varieties resistant to frost and Scab.

Trials There were no official trial centres fifty years ago, and we read that at that time this aspect was left to the trade itself. Those who grew on an extensive scale were the quickest to take up a variety and the first to discard it for fear of being ruined. The small-scale grower was less influenced by the profit and loss because the crop formed a smaller section of his business and he took less trouble to acquaint himself with what was going on around him; and then there were those who thought they would "just grow an acre of potatoes".

The first official potato-testing centre was set up in a kitchen garden at Ormskirk in 1915, and local farmers worked in close co-operation, alarmed by the rapid spread of Wart Disease in the north-western counties. On their own initiative, they took steps to inaugurate and support tests made on existing and new varieties for immunity from Wart Disease. In 1920, the National Institute of Agricultural Botany purchased a farm in the Ormskirk district and established a sub-station there. They took over the potato trial work, together with the staff, and continued to conduct the trials on behalf of the Ministry of Agriculture, on land heavily infected with Wart Disease.

In 1900, Wart Disease was referred to as a new disease of the potato, and the discovery of immune varieties first brought to light by Mr. Gough in 1908, provided a basis for new varietal selection. Facilities were provided at

Ormskirk for such a basis, thus giving a stimulus to breeders in their efforts to fill the gap in the choice of suitable kinds, which the official exclusion of susceptible varieties had occasioned; it also provided an opportunity for recording accurate descriptions of the botanical characters of the varieties examined. Thus started the reorganization of the potato industry.

In 1922, Miss M. Glynne of Rothamsted Experimental Station developed a method of laboratory testing for Wart Disease, and methods were elaborated at Ormskirk in order to carry out rapid susceptibility tests for the convenience of breeders, who now could receive reports in a few weeks instead of one or two years. The successful indoor test was developed and improved so that it could be used with confidence, and this was the main factor in inducing the Ministry to close the station there. In 1940, the Ministry decided to transfer the laboratory tests for Wart Disease to its Plant Pathology Laboratory at Harpenden, and at the same time establish field plots in the Wart-free area at the Midland Agricultural College, Sutton Bonington, now the Nottingham University School of Agriculture. Here, each year, plots are provided for the training of officers of the Agricultural Advisory Service who inspect the growing crops for certification under the Potato Health Certification Scheme. In addition, there are demonstration plots showing the various grades of certified seed produced in Great Britain, plots of new seedlings under trial, a museum of old varieties, and a collection of new introductions as they appear on the market. Another section contains examples of the various symptoms induced by virus diseases. The centre is also used by the Agricultural Research Council for problems now being investigated, such as virus diseases and storage problems; yield trials are carried out for the National Institute of Agricultural Botany, whose function, under their crop improvement programme, is to put new varieties into trials at centres throughout the country.

The number of plots planted in one season in recent years at the School of Agriculture exceeded 4,000—rather formidable when compared with 17 in 1915. The value of these plots has already been proved, not only in the training of personnel, but also by the interest aroused in the large number of visitors. Surely, in this combination of interests alone, progress can be said to be very marked, compared with, say, twenty-five years ago.

Scientific Developments It is not possible to mention each scientific development in the potato industry, but a few examples are cited here. Going as far back as the middle of the eighteenth century we learn that potato plants showed "curl" symptoms, and crops from these type of plants were much reduced. A Board of Agriculture advisory leaflet published in 1913 stated:

> It seems probable that the increased vigour of potato sets from Scotland and the North of Ireland is due not only to difference in soil and latitude, but to the extra moisture available during the growing period, and to reduced sunshine during the time of ripening. That Scotland and Ireland afford a good change of seed for England has long been known, but why this should be so it is not quite clear. A number of influences are probably at work.

A Ministry of Agriculture advisory leaflet* published in 1945 (thirty-two years later) gives enlightenment in this connection:

> In most parts of England potato stocks become unprofitable after they have been grown for one or two years only. This "degeneration," or "running out" as it was often called in the past, is due to the rapid increase within the stocks of two potato virus diseases—Leaf Roll and Rugose Mosaic (Severe Mosaic).

*Advisory Leaflet No. 139, "Potato Virus Diseases." Obtainable free from the Ministry, 1 St. Andrew's Place, Regent's Park, N.W.1.

> Stocks seriously affected with these diseases not only give poor yields, but may act as sources of infection for neighbouring healthy potatoes. For this reason a knowledge of the main facts about potato virus diseases should be an aid to growers, not only in the purchase of suitable seed stocks, but also in the handling of them so that losses from virus diseases are kept at a minimum.

The leaflet also contains information on the viruses causing this degeneration and advice on how to maintain healthy stocks. There was no mention of virus diseases in the 1913 leaflet, and the advice given in the 1945 leaflet may mean only a few new terms to the layman, but their significance to the whole of the potato industry is vast. The discovery that a potato variety does not die out from old age but from contamination with virus diseases has been of major importance during the past few years, when maximum production has been demanded, and thus the link between science and practice was strengthened as the necessity for increased production became more acute.

Many scientists have contributed to these findings during the past thirty years, and as a result of their efforts it has been possible to launch the Potato Health Certification Schemes throughout Great Britain. Some progress is now being made in laboratory testing for virus diseases and in the development of foundation stocks as a result of careful indexing. The occurrence and spread of virus diseases are closely correlated with the presence of certain aphides, and aphis prevalence is correlated with weather conditions. Some areas have now been "approved" as being suitable for foundation stocks to be built up and maintained from year to year. This development is due to our present knowledge of the spread of virus diseases in the field, coupled with good field or crop planning, isolation, and roguing.

No domesticated plant is more subject to parasitic or fungus diseases than the potato ; some of these still remain more or less a mystery, and the grower has to surmount them through tiresome or costly effort ; some are of little economic importance, but others may seriously or almost completely destroy the crop. The following are some of the problems now being investigated.

DRY ROT is an infection of the soil which leads to losses during winter and spring, usually after the stocks are delivered into the store. As the disease does not develop until after lifting, it depends on the conditions of storage of produce and the amount of wounding of tubers during harvesting, riddling, and transport operations. The greatest care should be exercized in handling potatoes (especially those varieties susceptible to Dry Rot) at every step on the way from the grower's field to the purchaser's store.

POTATO EELWORM is the cause of the condition known as "Potato Sickness," and the attacks are now fairly widespread throughout the country. No effective method of destroying the cysts on a field scale has yet been discovered, and the only suggested control at present is as long a rotation as possible between potato crops. The presence and persistence of ground-keepers (or self-sets) remaining from a previous crop is a serious contributing factor in hindering the decrease in the cyst content of a field falling to a level considered safe for planting.

BLIGHT was first recognized in this country in 1845 and is perhaps the most destructive disease affecting the potato ; the source of attacks still remains a mystery. Tubers may become infected if the spores of Blight are washed down into the soil. Good earthing-up is a safeguard. Other means of tuber infection occur at lifting time if the haulms have not been allowed to die down, or have not been burnt off, at least a fortnight before lifting. Blight does not spread from tuber to tuber in the clamp, but some which appear healthy at harvest-time may have a small centre of infection, and this develops rapidly if tubers are clamped in a wet state. It is essential

that storage conditions should be as cool and dry as possible in order to prevent wet rots developing.

COMMON SCAB is one of the most widespread diseases affecting the potato. The losses caused, although not so serious as in some potato diseases, are not by any means so insignificant as might at first be imagined. As a commercial article, the potatoes are rendered unsightly and their market value depreciates considerably. Further investigations into this disease are now being made.

We look forward to an early translation of the successful results of research into practical methods of control of these and many other problems.

Consumers' Preferences The consumer is as important to the industry as the grower and merchant; it is estimated that the annual consumption per person in 1947 was just under 3 cwt.—double that immediately before the war. Although diseases undoubtedly play an important role in determining the length of time during which a variety is cultivated, it should not be forgotten that popular fancy also has a strong influence. This can easily be traced to certain varieties having a direct bearing on a certain preference. For instance, fifty years ago the old Ashleaf Kidney, possessing a markedly pleasant flavour associated with new potatoes, was grown extensively, and it became so well known to the consumer that a preference for shallow-eyed kidney or oval varieties of this type followed, and the old sorts with round tubers and deep eyes were in much less favour. This is evident in the following classification of *white-skinned* varieties in general cultivation at present, and some new introductions, all of which are immune from Wart Disease.

Variety	Maturity	Shape	Eyes	First Tested in England
Arran Pilot	early	kidney	shallow	1928
Craigs Alliance	,,	oval	shallow	1947
Home Guard	,,	oval	shallow	1935
Ulster Chieftain	,,	oval	shallow	1936
Ulster Prince	,,	kidney	shallow	1946
Conference	second early	long oval	shallow	1943
Dunbar Rover	,,	oval	shallow	1933
Arran Banner	early maincrop	round	medium	1925
Arran Peak	,,	oval	shallow—medium	1933
Arran Viking	,,	oval	shallow—medium	1941
Dr. McIntosh	,,	kidney	shallow	1941
Doon Star	,,	oval	shallow	1925
Majestic	,,	kidney	shallow	(raised in Scotland in 1911)
Ulster Cromlech	,,	oval	shallow	1942
Ulster Earl	,,	kidney	shallow	1940
Ulster Leader	,,	kidney	shallow	1944
Arran Consul	late maincrop	oval	medium	1923
Dunbar Standard	,,	kidney	shallow	1934
Stormont Dawn	,,	kidney	medium	1939
Ulster Supreme	,,	oval	shallow—medium	1944

King Edward is susceptible to Wart Disease but it is very popular in England, and creates a good demand because of its regular shape and good quality, its red markings on the skin having become a feature of quality, thus setting a high standard for any new introductions of this type.

The production of parti-coloured varieties of earlier bulking capacity than King Edward is a new development in our potato culture. The following immune varieties produce tubers closely resembling King Edward, with red colour on the skin in and around the eyes.

Variety	Maturity	Shape	Eyes	First Tested in England
Ulster Premier	early	kidney	shallow	1943
Craigs Royal	second early	kidney	shallow	1943
Sutton's Olympic	,,	oval	shallow	1942
Ulster Ensign	,,	kidney	shallow	1943
Gladstone	early maincrop	oval	shallow	1930
Red Fife	,,	oval	shallow	1943

The Trade : Growers and Merchants A survey of existing varieties made in 1920 brought to light a state of affairs which has scarcely been recognized and the magnitude of which was beyond the wildest imagination, namely, Potato Synonyms. One great benefit being reaped as a result of past work is that the chaos found to exist in the trade concerning the naming of varieties is now well in hand. Potato synonyms—or, in other words, those found to be identical with existing kinds—have practically disappeared ; there were 72 per cent in 1920, and, moreover, they were often offered at enhanced prices. This was apparently not unusual fifty years ago, for it is recorded that a variety was charged £80 per ton under a new name for what under its original name could be bought freely for £5. This is how Dr. Redcliffe N. Salaman, Chairman of the English Potato Synonym Committee, summed up the position :

> Prior to the Ormskirk days, the potato had been regarded as a useful if rather dull article of food, any interest in which was, in the main, confined to the profits which might accrue in its exploitation. True, the monotony of normal trading might occasionally be broken by some financial boom, the most notorious of which occurred a few years before the Ormskirk activities began. On this occasion an inferior stock of an inferior variety was renamed Eldorado and sold for its weight in gold to a public only too ready to be beguiled. The excitement, the credulity, the folly, and the fraud, together with the final *dénouement* resembled the South Sea Bubble in miniature.

The present satisfactory state is one of goodwill existing between the trade, the departments concerned with the compiling of lists of potato varieties, and growers who are not now beguiled into paying extortionate prices for old or established varieties which have been merely renamed. Thus the abolition of potato synonyms has had a far-reaching and, we hope, permanent effect throughout the whole of the seed potato trade in Great Britain. Under present conditions, a new variety is tested in the official trials in England, Scotland, and Northern Ireland, and if it proves to be a distinct immune variety it is added to the list of approved varieties ("registered") after having been examined closely by the respective Potato Synonym Committees. It should be pointed out that distinctness of type and immunity from Wart Disease, though important, do not comprise the hallmark of perfection in a potato variety.

Some of the factors vital to any chance of successful cropping are wholly or partly in the hands of the grower, and neglect of any particular one may result in greatly reduced yields, and even serious crop failure. A few such features are : use of healthy seed, treatment of cut sets, size of seed and time of planting, and of course, manuring and cultivations, all of which are subjects for separate discussion.

In an attempt to regulate the potato industry in Great Britain, a Potato Marketing Scheme came into force in March, 1934, after having passed both Houses of Parliament; it was administered by a Board consisting of some thirty growers, elected by vote and representing all the potato-growing districts. The scheme was drawn up by potato producers themselves, its main objects being to prevent over-production in Great Britain and to limit imports from foreign countries. In brief, all growers of more than one acre had to register with the Potato Marketing Board and could dispose of their produce only through merchants duly authorized by the Board. The maximum acreage of potatoes allowed each grower was known as his basic acreage, and was that grown by him in 1933, or the average for the three preceding years. For each acre grown he had to pay the Board a levy of 5s., and if he wished to increase his basic acreage he had to pay a levy of £5 for each additional acre. The scheme was not a trading one; in times of glut the Board imposed the use of certain riddles, but it had no powers to fix prices. Seed potatoes were not affected by the scheme.

At first it bristled with difficulties, the main one being that the Board had to deal with some 75,000 growers, approximately 60 per cent of whom grew less than 5 acres each. To organize and influence thousands of independent and conservative growers was an arduous task, but the Board had the necessary powers to inflict penalties in cases where its regulations were not carried out. The mere fact that the scheme was the growers' own conception and entirely financed by them had a steadying effect on the individual farmer. The Potato Marketing Board was absorbed into the Ministry of Food during the war.

Potato merchants are as fully alive to potato problems as are the growers themselves; their interests in the crop are now wider than a mere business transaction. In 1945 a training course which has since become an annual summer course for representatives of seed potato firms was inaugurated at Sutton Bonington. They are thus able to keep abreast of the latest developments in agricultural research as affecting the crop, such as breeding work and storage problems, pests and diseases; and the trade is also kept up-to-date on the new varieties as they appear in commerce. There is no keener section of the potato industry than English seed potato merchants, and the opportunities now afforded by such organization should have a marked improvement on the industry as a whole.

The Search for Disease-resistant Varieties

In 1851 a New York minister made plans for breeding potatoes with the idea of developing more vigorous varieties that would be able very largely to resist disease. Among those he produced from South American kinds was one introduced under the name of Garnet Chili; from a naturally fertilized seed ball taken from that variety Early Rose was produced, and from that variety came many well-known kinds. Magnum Bonum and the old maincrop Langworthy are stated to be derived from a berry taken from Early Rose. We are directly and indirectly indebted to Garnet Chili for a large number of our varieties, including Abundance, Early Market, Epicure and Golden Wonder, the latter being a russet-skinned selection from Langworthy.

None of the varieties tabulated here is absolutely Blight-resistant, though some show varying degrees of resistance. The *wild* South American varieties are now being used in our breeding work; they have been classified and are available to breeders from the Commonwealth Potato Collection

at Cambridge. Some have proved to be immune from Blight, although their tubers are unsuitable for our type of culture. Success has followed the incorporation of such material in association with domestic kinds, in so far as immunity from Blight is concerned, simultaneously concentrating on commercial qualities. The potato-breeding programme now being carried out on these lines by the Scottish Society for Research in Plant Breeding shows that the Blight fungus has already developed three biotypes now recognized as "A," "B," and "C". "A" strain forms the Blight population under commercial conditions. So far no variety resistant to all three biotypes is available commercially, but two varieties resistant to "A" and "C" strains have recently been raised and named by the Society; these are Craigs Bounty and Craigs Snow-white, both maincrops with white kidney tubers.

We have gone a long way in the past few years—from the days of the old "C.L." (Clean Land Certificate), which had no bearing on the health of the crop and was merely a certificate indicating that the seed had been grown on land free from Wart Disease. The issue of this certificate was suspended when the 1941 Wart Disease Order came into force.

Acreages and Yields In 1900 the potato as a farm crop in Great Britain exceeded just over half a million acres yearly, and it appears to have been stabilized at that figure up to the immediate pre-war years. In 1948 the total acreage in the United Kingdom was slightly over 1½ millions, about 1 million acres being in England and Wales. Furthermore, there has been a fourfold increase in the use of Scotch seed in England and Wales compared with pre-war years.

The ten-year average tonnage per acre in Great Britain at the beginning of this century (1899-1908) was 5.85, and that for 1948 was 7.62. It would be very interesting to have the picture of the cropping trends in the maincrop group, in which there must have been a very marked increase during the past few years to compensate for the tonnage loss incurred by the lifting of an appreciable acreage of earlies at a 3–4 ton per acre level to fill the gap caused by the lack of imported earlies in the war years, and the still attractive prices ruling at the opening of the season.

The estimated crop harvested in the United Kingdom in 1948 was about 11¾ million tons, and was used in one way and another to help maintain about 50 million people in these Isles.

The acreage and tonnage have been raised, and this improvement is due to the production of heavier cropping varieties; scientific research into diseases and pest control; improved manuring and methods of cultivations; and the fact that aid of an advisory nature has been made readily available to growers. What matters most is this—is there an appreciable increase in the amount of food in good condition taken from the potato clamps? That is the marketable value of the crop. During times of stress, with greater demands on the crop, the potato has not let us down (supplies were rather low in 1947, but no blame for that could be put on the industry), and only co-operation of effort and coordination of ideas have achieved this end.

CIDER FOR FARMHOUSE AND HOME USE

Professor B. T. P. Barker, M.A.
Emeritus Professor of Agricultural Biology, Bristol University

WITH the development of cider-making into a commercial industry during the course of the present century, and the consequent production of cider passing very largely from the farm to the factory, the number of farmers continuing to make cider from the crops of their orchards is now relatively small. Hence, many of the younger generation have little experience or detailed technical knowledge of the procedure required to produce a satisfactory beverage. That there still exists among farmers and others a desire to make cider for home use is shown by the fact that over two hundred copies of a pamphlet dealing with small-scale cider-making have been distributed by the Long Ashton Research Station to inquirers since 1947.

The present article, which is largely an abbreviated form of the pamphlet just mentioned, indicates the procedure to follow in such cases to secure a sound product. Space will not permit of any detailed description of the equipment required: in fact the circumstances and conveniences of the individual intending makers probably vary so widely that a general account would serve very little useful purpose. Moreover, advice on such matters can be obtained direct from Long Ashton Research Station.

Good Cider means Good Fruit Although correct procedure is essential if the best possible results are to be obtained, that alone will not ensure that the cider, when made, will necessarily be a palatable and well-balanced drink. That result is decided by the fruit used. This point cannot be too strongly emphasized, and much disappointment and effort will be avoided if this is borne in mind. Unless the raw material is suitable, the drinking quality of the product will inevitably be inferior. Also, it must be recognized at the outset that quality changes as the fruit ripens, and therefore the degree of inherent quality of its juice for cider-making depends on the exact moment chosen to express the juice from the fruit. Faulty methods of juice management during the making period can afterwards lower the inherent quality, but even perfect methods of management cannot add to it. Thus there are two most important distinct points involved. The first is the kind of fruit used, and the second the decision as to the best time for milling and pressing it.

Dealing first with the kind of fruit, everyone knows that individual varieties of apples differ widely in their acidity. Cooking apples such as Bramley's Seedling are extremely tart or acid to the palate, the amount of acid in the juice being frequently well over 1 per cent. dessert apples, e.g., Cox's Orange Pippin, contain only about one-half that percentage and consequently, when eaten in the fresh state, are well-balanced in flavour and not too acid, because the natural sweetness of the sugar content of the apple counteracts and balances the acid flavour. Without that sugar even a Cox would taste somewhat over-acid: so, if the juice of this variety is made into cider and all its sugar destroyed in the course of fermentation, the resulting cider will be on the tart side.

In many cases, with suitable management and control of the fermentation, it is possible to stop the fermentation of a juice before all its sugar has disappeared, as will be described later: then the drink is not unduly acid to the taste.

It is obvious, therefore, that when culinary and dessert apples only are used for cider-making the question of an unpalatable acid flavour in the

drink is likely to arise to an extent depending on the degree of acidity of the particular fruit used.

The acidity of cider apples varies widely, some varieties being as tart as Bramley's Seedling apples, and at the other extreme some containing less than one-half the amount of acid of a Cox. In their case, then, it is possible by mixing appropriate varieties in suitable proportions to get a blended juice of any desired degree of acidity

For drinking purposes a "medium-sweet" cider of well-balanced flavour should contain approximately the same amount of acid as one made entirely from dessert apples. A "dry" cider, i.e., one in which all the fruit sugar has been fermented, is apt to taste too sharp if it contains more than half that amount of acid.

Increased character and fullness in flavour are obtained if cider apples of the bittersweet class are available for blending. This is due to the fact that they contain as a rule at least two or three times as much tannin as eating apples. Their acidity is less than one-half that of a dessert apple. Where available, they should be mixed with about twice their weight of medium sharp or dessert apples to give a balanced blend.

Harvesting and Storage The apples should not be gathered until they fall freely on lightly shaking the trees. Left till then, they attain full quality. Windfalls generally yield an inferior cider. Except for the earliest varieties, a period of storage is needed to reach the best state of ripeness from the cider point of view. That can be estimated approximately by a simple test to examine the degree of softening of the flesh. Take a few specimens and firmly press them between the thumb and forefinger. When such pressure makes a definite impression on the fruit readily, it is a sign that a fit stage of ripeness for milling to give a good yield of juice has been reached.

During storage the fruit can be kept in heaps, either outdoors or under cover, but it should not be left to lie in contact with grass or bare earth because of the risk of developing an earthy taste. The heaps ought not to be of greater depth than about two feet; otherwise the fruit may "heat" and the flavour become tainted.

On no account should the apples be left longer than absolutely necessary in the sacks or other receptacles used for their collection from the orchard. The freest possible ventilation is required for the maintenance of good flavour quality.

When the fruit has reached the right stage for milling it may need some cleaning and removal of rotten specimens if the harvesting has not been done with sufficent care: otherwise a tainted flavour in the juice may result. Bruised specimens are not in themselves materially detrimental so long as the surface skin is unbroken and rotting has not started.

In such cases washing the fruit with water is recommended as a simple and reasonably efficient method. Where the quantity is not great an open tub will serve, the apples being tipped into the water and stirred with a wooden stirrer for a few moments. Adherent dirt, grass and leaves are thereby washed away, while the rotten apples sink to the bottom of the tub. The sound apples float and can be collected readily for transfer to the mill.

Processing MILLING AND PRESSING. The methods of expressing the juice from the fruit by the combined processes of milling and pressing are outside the scope of this article; but, since for relatively small-scale operations the equipment used in individual cases will probably

vary appreciably in efficiency as regards yield of juice, a procedure for improving the yield of juice is worthy of mention.

After the milled apple pulp—or "pomace," as it is technically termed—has been pressed, the residue of the fruit tissue still contains considerable unexpressed juice. A fair proportion of this can be obtained by a second pressing. Before this is done, the residual pomace from the first pressing should be broken up as finely as possible and moistened by the addition of a small quantity of clean water. This aids the subsequent extraction of the juice by the second pressing, and a somewhat larger yield of a slightly diluted juice is thereby obtained.

FERMENTATION. *Preliminary Stage.* The expressed juice should be strained and put into thoroughly cleaned casks without delay, each cask being filled to the bunghole and kept in a cool place where the temperature is fairly steady. The use of clean casks is particularly important; many ciders which otherwise would have been good have been completely spoilt by flavour taints acquired from dirty casks.

Fusty casks should be ruled out absolutely. The others can be cleansed effectively by steaming—if a supply is available—after previous rinsing out with clean water. Failing steam, an alternative is a hot solution of washing soda in water (2 lb. in 10 gallons) or one of the various commercial detergents with antiseptic properties; this is left standing in the casks overnight. Thorough rinsing with cold water several times is then necessary to remove all traces of the solution.

Within a few days active fermentation starts spontaneously, the first signs being the discharge of a whitish froth through the open bunghole. This discharge may continue for several days, the froth carrying with it fragments of fruit tissue, which were in suspension in the juice. This frothy "head" should be removed periodically and the outside of the cask kept clean. After the discharge of the froth ceases—usually in about a week—the bunghole must be closed in such a way that the carbon dioxide given off during the later stages of the active fermentation period can escape, while the inlet of air is prevented. The simplest method is to insert a well-fitting bung loosely in the bunghole. The drawback to this method is that there is no outward and visible sign to indicate the progress of fermentation—whether it is still active, or slowing down, or at an end.

For that reason the use of some form of fermentation trap or air lock is an advantage. Of these, the simplest is a bent tube of glass or tin—*on no account should lead tubing be used*—the one end being inserted in a well-fitting cork closing the bunghole and the other end dipping into a jar of water placed on the cask close to the bunghole. The frequency of the escaping gas bubbles indicates the stage reached by fermentation.

Control of Fermentation. If left to itself the juice will usually continue to ferment until all the sugar has been converted into alcohol and carbon dioxide. The resulting cider is consequently "dry," i.e., lacking in sweetness. Whether a "dry" or a "sweet" cider is desired ultimately, it is an advantage to prevent too rapid or extreme fermentation. For this purpose, "racking" is helpful.

The process of racking consists essentially of a separation of the liquor from the layer of deposited yeast and other solid material which gradually settles down from the fermenting juice on to the bottom of the cask. This is done by carefully syphoning or pumping off the liquor into a clean cask. A rubber tube can be used for syphoning, or a small hand-pump for larger quantities. Care should be taken to avoid any preventable disturbance of

deposits in the cask and to carry out the complete operation with a minimum of exposure to air.

It is difficult to give precise instructions regarding the correct time to rack, as some juices normally ferment to dryness in fourteen days or less, whereas others retain a considerable proportion of their natural sugar over a period of two or three months, or even more. The nearest general guide as to racking time is when the fermenting liquor begins to show definite signs of clearing. Quick fermentations are usually a feature of the juices of cooking and dessert apples: these should be racked immediately after the solids cease to pass through the bunghole and again, after intervals, as may be necessary to hold the fermentation in check.

The juices of many cider apples of good vintage quality ferment at a slower rate, and clarification of the liquor tends to appear while some sweetness still remains. If racking is done then, the cider will generally hold its sweetness for some time. Should signs of renewed fermentation appear after an interval, a further racking may help to retain sweetness for a further period. Such naturally sweet ciders, if they have cleared reasonably well as the result of racking, are fit for drinking forthwith, although a period of storage for maturity normally improves the quality.

Dry Cider. The cider should be racked from its deposit before the actual end of fermentation, in order that the racked liquor may continue a slight fermentation and evolution of gas. This tends to prevent the development of acetic (vinegar) taint during the clarification stage.

When fermentation has stopped, the liquor is left undisturbed until it has cleared satisfactorily. Then it should be racked into its ultimate storage cask, this being filled to the bunghole and bunged down securely without delay.

Sweet Cider. Most people, other than seasoned cider-drinkers, prefer a "sweet" to a "dry" cider. It has been mentioned already that sweet ciders are sometimes obtained without special treatment owing to fermentation coming to a natural end before the whole of the fruit sugar has been converted into alcohol and carbon dioxide. Such cases are in the minority and cannot be relied upon to occur regularly.

It is possible, however, to make naturally sweet ciders from moderate or slow fermenting juices with reliability and without much difficulty if a suitable form of filter or centrifuge is available, the former being the more efficient. Both machines are too costly to justify purchase unless a substantial output of cider is contemplated or some other use for them is also served. Small separators of the type used by dairy farmers can be utilized in place of the larger type of centrifuge found in cider factories, if the bulk of cider is not large.

In either case the machine functions as a means of removing the yeast cells from the fermenting liquor, thus stopping, more or less completely, further fermentation. The treatment should be applied when the sweetness of the liquor has diminished to the desired degree. If one treatment does not stop fermentation entirely, it should be repeated about a fortnight later.

The alternative method of obtaining a sweet cider is to add sugar or saccharin, or a mixture of the two, to a dry cider. The addition should be deferred as late as possible before the cider is required for consumption, and the quantity used can best be decided by a small preliminary trial; usually about ½ lb. of sugar to 1 gallon of cider is sufficient.

Sugar should be dissolved in water at the rate of 1 lb. per pint and boiled for 15 minutes. The syrup must be cooled before being added to the cider.

Saccharin should be dissolved in warm water and added, to taste. "500" grade saccharin possesses a sweetening power 500 times as great as ordinary sugar. The use of saccharin will not impart any appreciable degree of "body" to the cider: although the sweetness may be comparable with a cider treated with cane sugar, the fullness of flavour will be much less.

After-treatment BULK STORAGE. It is essential that all casks of cider, whether in a state of active fermentation or not, should be kept full to the bunghole. Air must be prevented from reaching the liquor: if it is not, some vinegar fermentation is certain to take place. Evaporation is taking place constantly, and an air space soon develops. Examine each cask regularly at monthly intervals and fill the air space with added cider, if available; if not, add water instead.

USE IN DRAUGHT FORM. Cider for draught use can be drawn direct from the storage cask, if this is of not more than 6 gallons' capacity and likely to be emptied within two or three weeks. If likely to be longer, it is advised that when tapping the cask one-half of the contents should be bottled in screw-stoppered bottles. These can be reserved for use after the remaining liquor in the cask has been consumed.

With casks of larger size, the cider wanted for immediate use should be transferred to a cask not larger than 6 gallons and then treated as in the previous paragraph. The rest of the contents should be racked into another storage cask of convenient size and treated as described above for bulk storage.

BOTTLING. A dry cider will not develop much, if any, sparkling condition after bottling. Sweet ciders can do so, if not bottled too late in their life: if bottled too early, excess gas pressure may result, with a consequent serious risk of bursting. The approximate right time for bottling can be found by the following test. Fill two bottles three-quarters full: cork and keep in a warm place (65°-75°F.) for a fortnight. If then only a small deposit has formed and the cider is sparkling when poured out, the main bottling can be done forthwith. Should the deposit be heavy and the liquor overcharged with gas, bottling should be deferred and similar tests made at monthly intervals until the result indicated in the previous sentence is reached.

The bottles used should be capable of withstanding a fair degree of pressure. It is a wise precaution to examine the bottled stock at intervals for the appearance of excessive deposit or signs of too much gas pressure, with a resulting danger of bursting. Should such signs appear, remove the corks to allow the excess gas to escape and then re-cork.

Metals and Cider-making Contact of the fruit or liquor with metallic surfaces is almost inevitable at some stage. Most of the common metals are attacked, with unpalatable effects upon the flavour and possible danger to health in extreme cases. Suitable metals are stainless steel, gun-metal and tinned copper (if the plating is in good condition). Bare copper should be avoided, and also zinc galvanized surfaces. Lead, as already mentioned, is highly dangerous. Iron, although not harmful, causes discoloration of the mature cider. Brass and aluminium are undesirable, but may be used if scrupulously cleaned before and after use. Good quality enamel buckets are satisfactory, as also are wooden buckets if kept clean.

FARMING AFFAIRS

More Grass from Less Land Mr. D. H. Findlay, Director of the Yorks and Lancs Province of the N.A.A.S., broadcasting recently in the North of England Home Service, drew attention to the possibilities of getting more grass from fewer acres, and so releasing more land to grow crops for human and livestock consumption.

"Obviously if we grow more arable crops for human consumption and livestock," he said, "we shall have fewer acres of grass, but we can still have more grass, by making those fewer acres more productive. Last year we had a visitor over here from New Zealand. He'd visited many countries and he was very complimentary to our farming. He did however make some reservations about our grass. He said to me : 'I've noticed that you people here seem to have a great veneration for ancient monuments—at least I cannot think of any other reason why you don't put the plough into some of these old hidebound, benty pastures of yours.'

"Now I think he's quite right : I'm not going into details but there are just one or two suggestions I want to make.

"Firstly I believe that much of our good grass can be made even more productive by being fairly generous with lime and fertilizers. I was over in Holland not long ago, and I must say I was tremendously impressed by the output of grass they were getting on some farms there—and they do use a lot of fertilizers. That I think is one thing we might think about.

"My second point about grassland improvement refers to the poorer grass. Here I believe in the plough—turn the old stuff underneath and reseed—either directly or after a few crops.

"When we get on to the really poor stuff—the marginal land—I want to suggest a little caution. I've seen quite a lot of this stuff ploughed up and reseeded and after a few years go back to a condition very little better than it was to begin with. If land is really poor you can't expect it to grow a first-class sward straight away, and the first thing to do is to raise the fertility of the land. There are different ways of doing that—as good a way as any is to grow one or even two pioneer crops—rape or rape and soft turnips, or a cheap mixture with rape and Italian ryegrass. Eat these crops off on the land with sheep and then you'll have a much better chance of getting a decent sward to grow."

Research Institutes for Engineering, Grassland and Vegetables Three agricultural research institutes have been established as from October 1 by the Ministry of Agriculture acting in co-operation with the Department of Agriculture for Scotland and the Agricultural Research Council. They are under independent governing bodies constituted as companies limited by guarantee and without share capital. Particulars of the institutes are as follows :

National Institute of Agricultural Engineering. This Institute has its headquarters at Silsoe, Bedfordshire, and was formerly under the direct control of the Ministry of Agriculture, with a Scottish sub-station at Howden, Midlothian, which was under the direct control of the Department of Agriculture for Scotland. The staff and work of this Institute have been transferred from the Ministry of Agriculture and the Department of Agriculture for Scotland to the new independent governing body under the chairmanship of the Rt. Hon. the Earl of Radnor. Mr. W. H. Cashmore continues to be the Director of the Institute.

Grassland Research Institute. The headquarters of the Grassland Research Institute will, for the time being, be at Drayton, Stratford-on-Avon. The new governing body has taken over from the direct control of the Ministry of Agriculture the work and staff of the Grassland Improvement Station at Drayton, together with the responsibility for developing a new site at Hurley, Berks, to serve as the new headquarters of the Institute. The Chairman of the governing body is Professor H. G. Sanders of Reading University, and the Director of the Institute is Dr. William Davies, who was formerly Director of the Grassland Improvement Station.

Vegetable Research Station. This is a newly-established Institute, except that it has taken over from Cambridge University the work and staff of the Horticultural Research Station there. The headquarters of the Vegetable Research Station will be at Wellesbourne, Warwickshire, and it also has a sub-station at Paglesham in Essex. The Chairman of the governing body is Professor F. T. Brooks (Cambridge University), and the Director is Dr. J. Philp.

These three institutes will be financed by grant-aid from the Ministry of Agriculture and the Department of Agriculture for Scotland, and will come under the scientific oversight of the Agricultural Research Council. They will thus join the family of agricultural research institutes, comprising such well-known centres as Rothamsted Experimental Station, East Malling Research Station, and the National Institute for Research in Dairying.

Calf-rearing Subsidy If Parliamentary approval is granted, the calf-rearing subsidy will be extended to cover calves born up to September 30, 1951. Subsidy at the rates of £5 a head for steer calves and £2 for heifer calves will be paid in respect of calves born after October 1, 1949, and before October 1, 1950, which are certified to be suitable for beef production or as dairy herd replacements.

The subsidy rates payable on calves born after October 1, 1950, and before October 1, 1951, will be announced later.

Nature Month by Month—November Only the enthusiast is out and about for pleasure on these chill November days. Keeper and bailiff, woodcutter and farm-worker plod homeward with visions of fireside and good cheer to come.

In the paddock this evening there are no feeding rabbits, even on the lee side of the hedge, but maybe they will be out after dark. This morning a cock sparrow-hawk cruised swiftly down the hedge and away across the lane at the end of it. He had no luck that time; through the bare hedge the small birds saw him coming. On the farther hillside a disconsolate-looking hare lopes slowly along, picking its way through the sodden herbage.

In the crevices of our rockery and in the earth beneath it sundry toads and lizards have holed up for the winter. One of the toads, I think, is a former "pensioner" of ours. All the garden flowers that are left to us are a few dying dahlias and Michaelmas daisies, and some chrysanthemums which alone seem in full bloom and vigour. Active insect life is almost wholly absent. Our orchard nest-boxes are in demand as winter dormitories. One morning last week, at daybreak, no less than five tiny wrens came out of one of them. I remember that some years ago the wrens used a martins' old nest beneath the farmhouse eaves.

The belfry of the little, grey village church harbours a multitude of sleeping bats, and in porch and aisle are a fair number of small tortoiseshell and peacock butterflies. Up on a cross-beam there still remains the nest of a pair of swallows which, back in the summer, reared their young in

sanctuary, unperturbed by the noise and movement of human congregations. The birds, young and old, went overseas some time ago.

The river is in spate and bank high. Where, a week ago, were crystal pools and little feathery falls is now a roaring brown flood that obliterates all but the most prominent features of the river bed. Across the biggest pool there lies a dead, partly submerged pine, looking for all the world like the backbone of some prehistoric monster. More than the spate will be needed to move it.

The Moor, now, is grim and sombre ; rusty with dead ling and bracken, dripping with the cold rain that for a day and a night blew in from the sea. From a nearby tor a raven croaks a note in keeping with the scene. For the man who does not know it really well the Moor is a place to avoid for months to come ; some of the mires are deep and dangerous.

Winter is undisguisedly with us, now, with cold and fog and maybe snow ahead. The days will be short but the time will seem long before spring is here again.

F.H.L.

BOOK REVIEWS

Readers' Guide to Books on Agriculture. LIBRARY ASSOCIATION (County Libraries' Section.) 6d.

The realization of the importance of British agriculture has never been greater than it is today. This book list, which provides a useful guide among the great mass of farming literature (up to November, 1948), is therefore very welcome.

The material is arranged under eight main headings—farming background, the soil, plants, animals, farm machinery and buildings, farm products, economics and education, and there is also an alphabetical subject index, complemented by a system of cross-references to related topics.

F.C.H.

Diseases of Cereals and **Diseases of Potatoes, Sugar Beet, and Legumes.** W.A.R. DILLON WESTON. Longmans Green. 4s. each.

Very few up-to-date accounts of diseases of farm crops have been available for some years past, and these cheap and handy booklets are, therefore, sure of a warm welcome. They will be found particularly useful by both farmers and students, as the information is clear and practical. The illustrations by Ann Murray summarize the main points of the life cycle and control of each disease in an interesting way. The historical approach to the subject in the first two chapters on potato diseases is unusual in elementary books and is most instructive.

The information presented in both books is accurate as well as concise, and few slips have been noticed. Seed potatoes to qualify for an "H" certificate must now come from crops showing not more than 2 per cent severe virus, not 3 per cent as formerly. On land where the potato eelworm population is low it is stated that potatoes should be grown only once in four years ; it would have been well to have added the qualification contained in the Ministry's Advisory Leaflet 284 that once in every five years is preferable. Although the oats strain of Take-all occurs as is stated in the North of England on both wheat and oats, it is not common enough to make it necessary to avoid oats in the crop rotation.

The publication of further volumes to complete the series will eagerly be awaited.

A.B.

The Cost of Grassland on Seventy-five Farms in the West of England. V. H. BEYNON and M. B. JAWETZ. University of Bristol, Department of Economics.

A survey of 75 dairy farms in the West of England in 1947–48 shows that the annual cost of pasture is £3 15s. 6d. per acre, whilst the cost of hay and silage (excluding making, etc.) is £4 10s. 9d., the difference being due almost entirely to higher expenditure on manure and labour ; in each case rent is the highest single cost. The cost for establishing new leys is £6 1s. 9d. per acre for pasture and £4 18s. 1d. for hay and silage, the difference being due to higher cost of seeds for pasture. However, the acreage of new leys was only 6 acres per 100 acres of pasture and 9 acres per 100 acres of hay and silage. More stock could be carried if the acreage of new leys were increased. High labour charges for unproductive work, i.e., hedging, ditching, etc., and rent are relatively constant from year to year, and, spread over a larger number of stock, would reduce the aggregate cost of grazing per acre, which is £4 6s. 2d. on the average, ranging from under £2 to over £12.

The report brings out what the authors call a "disconcerting point," i.e., the paucity of manure applied on the farms surveyed. Twenty-nine per cent of the farmers applied no manure to pasture, and 9 per cent did not do so for hay and silage. Of the farmers using fertilizers, 69 per cent used no nitrogenous fertilizers and 67 per cent used no phosphates on pasture. The figures for hay and silage are 57 per cent and 51 per cent respectively. As the authors say : "It is imperative that the additional quantities of fertilizers made available should be applied to grassland if this country is to produce extra food to the value of £100,000,000 annually within the next few years."

R.A.R.

Profit from Fertilisers (3rd Edition). CROSBY LOCKWOOD. 15s.

The third edition of this well-known book, which contains chapters by six different authors, has appeared only three years after the issue of the second edition, whereas the second edition appeared eight years after the first. This doubtless reflects the much greater number of farmers who are now really interested in using fertilizers to their best advantage. The purpose of this book is to help such growers, and to show them how profitable is a proper use of fertilizers. The problems are a little difficult because sometimes one should use a mixed fertilizer and at other times a single straight fertilizer, but the reader will find they are discussed very clearly in this book.

Parts of this book are begining to lose their original value by being rather out of date, and this concerns particularly the chapter on the types of fertilizer available. No indication is given of what fertilizers have been available since, say, 1944, when the second edition of the book was issued, nor is it stressed that the composition of some fertilizers, as, for example, muriate of potash, depends purely on what manufacturing process it is most convenient to use. Thus though 60, 30 and 20 per cent muriates are all discussed, the possibility of the existence of the 40 per cent in use at the present time is not even hinted at.

The three main chapters that have had extensive revision are all excellent. Two are by Sir George Stapledon on the manuring of leys, pastures and hill grazing, and the only comment here is that the paragraph on the manuring of grass for drying is quite inadequate. The third is by Mr. F. Rayns on the manuring of arable crops, and again the farmer will find invaluable and sound advice on the proper use of fertilizers for each of the main farm crops. Mr. Rayns stresses in particular the great value of adequate dressings of nitrogen, for there is probably no easier way of increasing the productivity of our farms than by encouraging a more widespread use of nitrogen fertilizers.

E.W.R.

Methods of Test for Soil Classification and Compaction (British Standard. 1377). BRITISH STANDARDS INSTITUTION. 7s. 6d.

Standard methods for the determination of the moisture content, liquid limit, plastic limit, plasticity index and liquidity index of soils, of the specific gravity and size distribution of soil particles, and for some soil-compaction tests are described with full working details. The methods are intended to be used in road-engineering work, but many of the details were worked out originally for agricultural soils, and some of the methods could advantageously be adopted as standards in agricultural work.

G. V. J.

BOOK REVIEWS

The Right Way to Pig Keeping and Breeding. ALAN MORLEY. Right Way Books, Rolls House Publishing Co. 5s.

A concise, comprehensive and well-written textbook. Mr. Morley has given us a really up-to-date treatment of his subject, especially in the chapter on pig-keeping in times of emergency, where he displays his personal experience of the problems likely to be encountered. Another particularly pleasing section of the book is that devoted to feeding, where much sound information, relevant to both present conditions and those of more normal times, is presented. It is a pity that no word of warning is given to the newcomer in this otherwise admirable section about the difficulty in obtaining some of the feedingstuffs.

A timely reminder of pre-war conditions in the industry, including a review of the economics of the pig cycle, coupled with a warning of a possible recurrence of this state in the future, is noteworthy. In view of the present vacillating state of the industry Mr. Morley, wisely, makes no attempt to estimate returns from a pig-keeping enterprise, although he is optimistic about the future and concludes his book with some very sound hints to those about to start such a venture.

Informative and interesting chapters on other aspects of pig husbandry are included, together with a few well-chosen notes on backyard pig-keeping.

R. B. W.

Pigs. J. W. REID. Farmer and Stock-Breeder. (Spon Agricultural Series). **16s.**

This book has been compiled from lectures given to students by the author, over a period of twenty years. These have been brought up to date, and this information, together with Mr. Reid's practical experience gained whilst supervising the herd of pigs at the Hertfordshire Institute of Agriculture, makes the book most acceptable to anyone with an interest in pigs or pig-keeping.

The student searching for knowledge, or the practical pig-keeper, will find the book of immense help. It combines the theoretical and the practical sides of pig husbandry in a most satisfactory way. It covers all the aspects of pigs and pig-keeping. The chapters dealing with the pig industry will be of most help to the student whilst those on economics and pig housing make worthwhile reading for anyone starting pig-keeping at the present time. Herdsmen will find much to interest them in Mr. Reid's writings on feeding and management, and they should benefit considerably from the many very practical tips given, some of which may be well known but all of them well tried and of proven value.

The data collected from Pig Recording Societies and Breed Associations is a valuable asset to a book of this kind, and it helps to illustrate the value of good management.

The main breeds are dealt with, although not in great detail, and perhaps a little more discussion in the chapter dealing with the selection of breeding stock would have been welcomed by the beginner. Hygiene is discussed at sufficient length for the pig-keeper, and the book ends with a short treatise on slaughtering and processing.

W.L.

British Reptiles and Amphibia. MALCOLM SMITH. King Penguin Series. 2s. 6d.

Literature on this subject is none too plentiful, and the amateur herpetologist, especially, will be glad to have this publication. Here, for 2s. 6d., is all that he needs to know about our snakes, lizards, newts, toads and frogs. The name of the author is sufficient guarantee that the book is reliable and up to date.

One cannot refrain from hearty agreement with the author's opinion that "It is just as well" that attempts to introduce the marsh frog into parts of England, other than the Romney Marshes, have failed. Apart from the other possible unfavourable results, as the author says "A chorus of males in full song after dark has been known to keep a whole village awake," and in these days few would wish to add to the alien noises of the countryside.

The illustrations by Paxton Chadwick are almost uniformly good, although the purist might perhaps question whether the general coloration of the grass snake is truly typical. One would have liked to see, also, illustrations of a few of the colour variations of the adder.

These, however, are minor points, and author, artist and publisher alike are to be congratulated on this admirable little publication.

F.H.L.

BOOK REVIEWS

New Plants of the Year, 1948. ROYAL HORTICULTURAL SOCIETY. 12s. 6d.

To quote the Society's modest title, this is a "Descriptive list of all plants, flowers, fruit and vegetables that have received awards from the Royal Horticultural Society after exhibition at Vincent Square or after trial at Wisley during 1948." It is, in fact, a well-bound 80-page book containing 55 illustrations, of which eleven are coloured reproductions.

The Royal Horticultural Society has eleven committees, composed of the leading experts in every branch of horticulture. One of the functions of these committees is to examine in detail the large number of new species and hybrids which are sent to the Society by commercial and amateur growers, not only in this country but from all parts of the world, and to give awards to the best. Large numbers are continually undergoing trial in the Society's gardens at Wisley.

Nearly 600 different hybrids and species are described in detail. There are seven main groups with their subdivisions as follows: trees and shrubs, of which the chief genera dealt with are camellia, magnolia, rhododendron and rosa; bulbs and corms (main genera freesia, gladiolus, hippeastrum, iris, lilium, narcissus, and tulipa); rock garden plants; orchids; herbaceous plants (mainly perennial asters, calendulas, border carnations, garden pinks, chrysanthemums (of which 90 new varieties are described), dahlias, delphiniums, lupins, primula, sweet peas, and tagetes; fruit—one apple, Laxton's Fortune, and one strawberry, Auchincruive Climax; and vegetables (mainly cauliflower, lettuce and Brussels sprouts).

Although some of the awards are described from time to time in the *Journal of the Royal Horticultural Society*, it is very desirable to have a complete and classified list in a separate publication, and this book is one which no horticulturist who wishes to keep up to date with the newest and best varieties can afford to be without.

E.S.

Root Crops. H. I. MOORE. Farmer and Stock-Breeder. (Spon Agricultural Series). 14s.

In the last twenty years the arable farmer, especially in the eastern counties, has had to discard the traditional technique of growing fodder roots and learn how to grow sugar beet and potatoes. Since the introduction of sugar beet into British farming, research on this crop has been highly organized and intensive, but the full account of the results of this work has yet to appear in book form.

The husbandry of the potato crop is, however, more fully documented, and detailed descriptions of the best practice of the specialized potato-growing districts are already in existence.

But for the farmer and student who requires a clear, general picture of the present knowledge about the old-established feeding roots and less familiar cash root crops, Professor Moore's book in the Farmer and Stock-Breeder Agricultural Series will be of great service. Besides a full practical account of the cultivation, manuring and harvesting of the different root crops, there are useful chapters on the mechanization of the root crop and seed production. A valuable feature is the inclusion of recent experimental results which not only add convincing support to the argument, but underline the trends of research and what developments may be expected in the future. Where detailed figures are quoted, however, it is suggested that the complete reference should always be given, as experimental findings detached from the "background" of the field trial may sometimes be misleading.

One or two minor comments may be made. On page 78 it is stated that 6 lb. of segmented sugar beet seed is equivalent to 15 lb. natural seed; experience, however, has shown that double this quantity is usually required. Again, reference to the pelleting of beet seed with fertilizer requires the necessary qualification that for the beet crop the drilling of fertilizer in contact with the seed usually has a marked adverse effect on germination.

P.N.H.

Farm Enterprise Mechanics. Edited by R. W. GREGORY. J. B. Lippincott Company. 18s.

This book is designed principally for those engaged in vocational teaching and for those who, having had such training, wish to extend their skill and put it to practical use. Nevertheless, for the farmer who has no workshop or only an inadequately equipped one (and how many there are!) it should be of value, especially if there is a handyman available who, whilst not a skilled carpenter or mechanic, has sufficient knowledge of tools to want to know more. It also gives constructional details of devices and equipment that can be made on the farm.

A.B.

There are full lists of tools for workshops on farms of various types and sizes, and advice on the use, care and sharpening of tools, soldering, concreting, and farm and house plumbing ; a mass of other information is also given. The repair and adjustment of farm machinery and implements is treated in an understandable manner.

Quick reference is facilitated because the book is arranged in chapters, each dealing with specific subjects, such as the farm shop, field crop equipment and repair, poultry appliances and buildings, dairy equipment and buildings, orchard equipment, garden and market garden tools, household equipment and repairs, and so on. An appendix supplies data about nails and screws, uses for old crankcase oil and inner tubes, cubic measures and the like.

A random selection of things to make and do will perhaps give a better idea of the scope of the book. Here it is: Sharpening saws, making gates, laying tiles, concrete floors for pig-sties, pig houses, hen coops, chicken feed hoppers, knots and halters, sheep loader, saddler's clamp, beekeepers' appliances, tree props, spray mixers, fruit crushers and driers, heated seedling beds, bookcase and filing cabinet, ironing board, electric wiring. A number of these individual paragraphs refer the reader to U.S.A. pamphlets, yet many give enough details to enable a practical man to set about a job in a way which has been found by experience to be satisfactory.

C.D.

I Went A'Shepherding (Third Edition). RICHARD PERRY. Lindsay Drummond. 12s. 6d.

Mr. Perry is a field naturalist of established reputation. The necessities of national service sent him a'shepherding in the West Highlands during the war years, and in this book he records his experiences there. He lived and worked as a hill shepherd in Skye, North Uist, and Argyll, and his story of hill shepherding is both vivid and accurate. At times, perhaps, he tends to exaggerate the rigours and hardships of the job. To those bred and brought up to hill shepherding, such hardships seem less remarkable. Nevertheless, these accounts of the care and management of Blackface sheep in some of the most difficult sheep-farming localities of Scotland, as seen by an educated naturalist, have a very definite agricultural value. There have, in the past, been too few first-hand accounts of the way of living of the farming and crofting communities and their animals in the remotest parts of the kingdom by those educated and trained to interpret their observations.

This book, one of several dealing with the somewhat primitive life and agriculture of the West Highlands and Islands, has had a quick success and found a wide public. That success is deserved, since Mr. Perry's book is much better than many of its kind. His style is distinguished, his matter free from false sentiment, his sense of humour delightful. Then, of course, there are the birds ! Even when working with sheep, Mr. Perry's eyes are never far from his real enthusiasm. His description of the " splendid dance of the wild swans " is the finest passage in his book—a magnificent passage in *any* book.

Rather unfortunately—one feels at his publisher's suggestion—Mr. Perry has been induced to write a postscript on "The Future of the Blackface Sheep-Farms". This would be better omitted from further editions.

A.F.

One-horse Farm. RAYMOND O'MALLEY. Muller. 12s. 6d.

Mr. O'Malley is a schoolmaster by profession. He became a farmer during the late war by direction of the Appeal Tribunal. Pacifism certainly brought some able pens to the description of farming operations. Mr. O'Malley writes well : ". . . the barn had the exaggerated calm of a chapel". He is also a skilful photographer, and some of his pictures—for example, those of hens in snow and of a horse rolling—have a noteworthy originality.

After some preliminary experience as a hired agricultural worker, Mr. O'Malley rented the farm of Achbeg (Gaelic for Little Field) in Western Ross-shire. The farm possessed 19 acres of arable ground and 193 acres of rough grazing. It carried a tied flock of 100 Cheviot sheep.

Intellectuals seem to be very fortunate in their farming adventures in the West Highlands. There is always some neighbour called Donald, or it may be Ian, who really *can* farm and who keeps things going until the intellectual retires nearer the civilization he professes to abhor and writes the inevitable book.

In some ways Mr. O'Malley's book is better than many of its kind. He writes pleasantly and sensibly of hill farming routine, of cattle, of sheep, of poultry, of hill haymaking. His facts are accurate and his observation acute, yet strangely enough, although this is supposedly a book about crofting agriculture, the most interesting chapter is a quite profound essay on Folk Art. Mr. O'Malley gets to the root of the controversial matter of the correct way to sing a Gaelic song. Realizing that conventional tone production is quite the wrong approach, he writes: "The performers are taught to aim at a rich or mellow tone, where the songs require a much thinner, more astringent quality of voice. The difference is as great as that between flute and clarinet." For such a clear analysis one may forgive many farming platitudes and peculiar political views.

A.F.

BOOKS RECEIVED

A History of English Farming. C. S. Orwin. Thomas Nelson. 8s. 6d.

Canning Practice and Control (3rd Edition, Revised and Enlarged). Osman Jones. Chapman and Hall. 36s.

Corn and Corn Growing (5th Edition, Revised). Henry A. Wallace and Earl N. Bressman. Chapman and Hall. 27s.

Severn Stream. Brian Waters. J. M. Dent. 15s.

Foot-Path Through the Farm. C. Henry Warren. Falcon Press. 7s. 6d.

How to Bottle (Revised Edition). George Fowler. Fowler, Lee and Co. 6s. 6d.

Chrysanthemums for Pleasure and Profit (4th Impression, Revised). Roy Genders. Littlebury. 7s. 6d.

Bird Migration (3rd Edition). A. Landsborough Thomson. H. F. and G. Witherby. 8s. 6d.

The Geology of Water Supply. Sir Cyril S. Fox. Technical Press. 25s.

The Fruit Year Book. 1949. Royal Horticultural Society. 8s. 6d.

The Fruit-Grower Year Book, 1950. Benn Bros. 8s. 6d.

The Annual Report of the Agricultural and Horticultural Research Station (The National Fruit and Cider Institute), Long Ashton, Bristol (1948). University of Bristol. 12s.

Deserts on the March. Paul B. Sears. Routledge and Kegan Paul. 10s. 6d.

"AGRICULTURE"

Price 6d. net monthly, post free. (Foreign countries, 8d. post free).

Subscription Rates (including postage) :

Inland and Imperial .. .. 6s. per annum

Foreign Countries .. .. 8s. per annum

Subscription may start with any issue and should be sent to

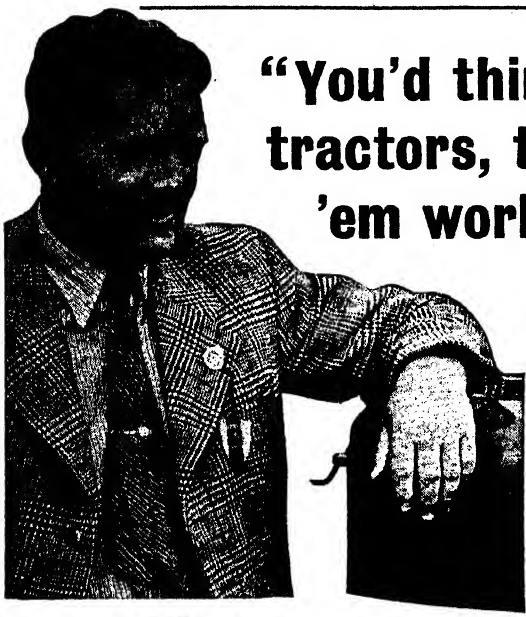
H.M. STATIONERY OFFICE

York House, Kingsway, London, W.C.2; 13a Castle Street, Edinburgh 2; 39 King Street, Manchester 2; 2 Edmund Street, Birmingham 3; 1 St. Andrew's Crescent, Cardiff; Tower Lane, Bristol 1; 80 Chichester Street, Belfast.

Single copies can be purchased from any of the above-mentioned addresses or through a bookseller.

Printed in Great Britain under the authority of HIS MAJESTY'S STATIONERY OFFICE by C. Nicholls & Company Ltd., The Philips Park Press, Manchester, London and Reading

FARMERS' FORUM No. 3



"You'd think I hated tractors, the way I make 'em work!"

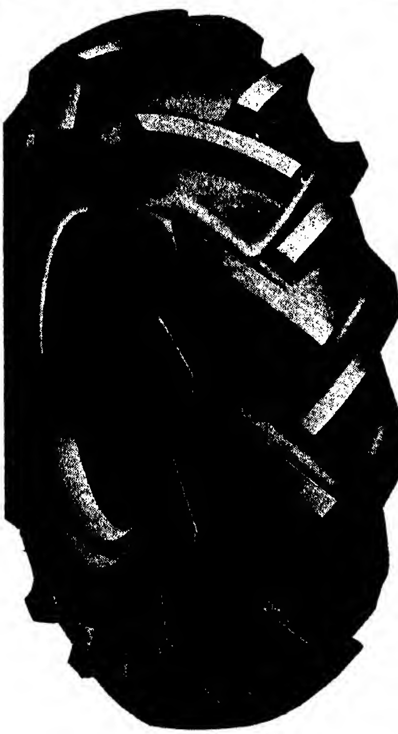
SAYS MR. PHILIP HALL, ENTERPRISING YOUNG POWER-FARMER OF CREDENHILL, HEREFORD.

"—Engine-power is there to be used. I use it from dawn till dusk, on every possible kind of job — as a result I get through more and more work in far less time."

Mr. Hall plans each tractor's day down to the last five minutes. Besides field work, he uses power for every possible haulage and transport job. And success is proving him right. Down at Credenhill he grows wheat, barley, oats, hops, root crops, and fruit; he raises fine Hereford cattle, sheep and pigs, and also does a specialist line in Rhodes, Sussex and Leghorn fowls.

A great believer in pneumatic tyres, Mr. Hall has nearly all his tractors and implements mounted on Goodyear. Here's the way he argues: Speed is money to the power-farmer, and Goodyear tyres keep farm work steadily on the go in practically all weathers. They greatly increase turnover, economise in fuel and labour costs, and protect implements from "Clatter-batter wear and tear", as Mr. Hall picturesquely puts it. In addition, Goodyear tyres outlast all others.

" You can quote me as a Goodyear enthusiast," says Mr. Hall.



GOODYEAR build tyres for every farming job—to help you get through the work quicker, without the "judder" that ruins good implements.

In particular, the Goodyear Sure-Grip Tractor Tyre with its famous o-p-e-n c-e-n-t-r-e tread gets your tractors through more work in less time than you ever thought possible. Look at those mighty lug-bars! See the bite-points? . . . They dig deep into the ground, followed by the whole length and breadth of the lug-bars. Four-at-a-time those rugged self-cleaning Goodyear bars drive the tractor forward, extracting the uttermost ounce of power from your engine by sheer, down-to-earth *wheel-adhesion.*

Speed the plough with

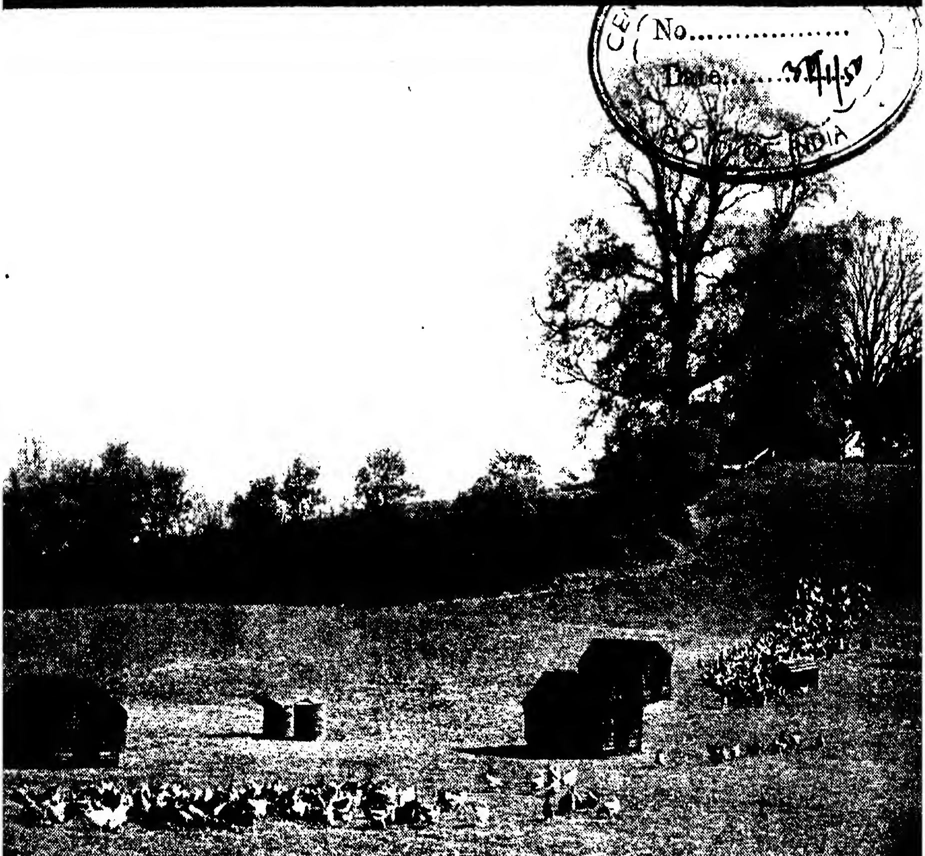
GOODYEAR

SURE-GRIP TRACTOR TYRES

and grow more food for Britain

Please mention the JOURNAL *when corresponding with Advertisers*

Agriculture



PUBLISHED 6^{d} MONTHLY

Please mention the JOURNAL *when corresponding with Advertisers*

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

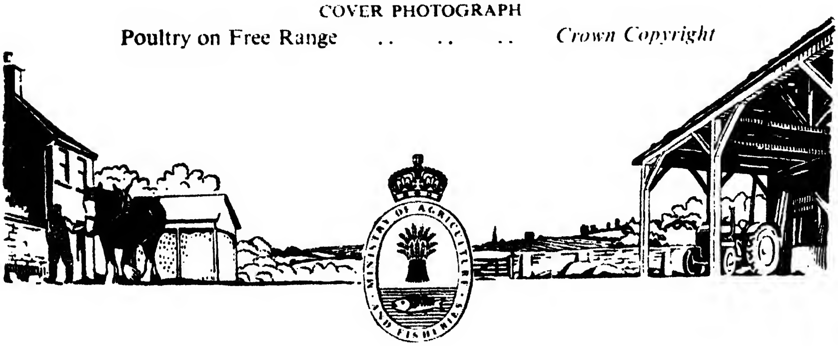
Editorial Offices: St. Andrew's Place, Regent's Park, N.W.1 (*Phone:* *WELbeck* 7711)

VOL. LVI | No. 9 | DECEMBER 1949

Contents

COVER PHOTOGRAPH

Poultry on Free Range .. .. .. *Crown Copyright*



AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LVI No. 9 DECEMBER 1949

THE PLANNING OF LAND USE

This year's Presidential address to the Geography Section of the British Association for the Advancement of Science

PROFESSOR L. DUDLEY STAMP, C.B.E., D.Sc., B.A.

IT has been said that any country has but two ultimate assets—its land and its people. The use made of the former depends upon the intelligence, the skill and the objectives of the latter. Obviously "land" in this sense includes the resources which lie below the surface as well as those of the surface and of the associated bodies of water. The planning of land use is thus, in fact, planning for the full development and use of natural resources. Only slowly are we coming to the realization that the resources of the world are finite and that the continuance of the human race in the long run must depend upon the intelligent planned use of those resources—especially of food-producing land. This is essentially a long-term view and it is not surprising to find frequently a sharp conflict with a short-term economic viewpoint. There is also a conflict at times with the professional planner, especially the urban town planner, whose basic training is as an architect or surveyor, and who through failure to appreciate such natural factors as the disposition of minerals, or the qualities of soil and land, may achieve a particular aim in planning only at the expense of sterilizing resources in the long run vital to the human race.

The planning of land use in any country must be viewed against a world background—a world population of 2,200 millions, increasing at a rate of 20 millions a year; more rapidly than the application of science to production can augment food supply and at a time when there are no more virgin lands available for easy conquest, only tropical lands where reclamation must inevitably be slow and costly even if eventually successful. The word planning has to some extent incurred popular disfavour. Its association with the advocacy of some particular recipe for erasing ills, its supposed dependence on theory and divorce from reality, still more the concept of a plan as a straight-jacket regulating our present and our future, have all contributed to this unfortunate position. In reality the world as a whole (and each country individually) is faced with the urgent need of developing and using its natural resources more scientifically and more intelligently than in the past. This is planning: the long-term plan is simply the formulation of certain principles, and the short-term plan a specific development within the general.

Land use planning is not an end in itself; its purpose is to secure what is loosely called an improved standard of living for mankind. I have discussed on more than one previous occasion what are the basic needs of man which must be satisfied by a proper use of land and have suggested that there are at least six. One is work, which brings to the forefront the

location of industry and the fact that the majority of industries are tied by natural factors such as the occurrence of coal, or other minerals, the need for a waterside location, and so on. A second is a home and hence the whole need of land for housing and town planning in the restricted sense. A third is food—even more basic for human survival, though apt to be forgotten by a nation which thinks only of food coming out of shops—and with food raw materials of animal and vegetable origin. With man's need of food we naturally link need of water. A fourth need of man is recreation for mind and body, which again has its land use aspects. A fifth need is mobility—means of communication—and so land for railways, roads and airfields. A sixth need is security and brings into the picture the requirements of the fighting services for training grounds.

Modern land planning involves the balancing of each of these claims on its quota of a strictly limited area of land. We may urge that for any given tract of land there is an optimum use in the national interest, though use at any given time is not necessarily permanent and many types of land can serve more than one use at the same time (multiple use of hill grazing for sheep, water supply and recreation is an example).

The problem is obviously acute in such a country as Britain but none the less real all over the world. Conservation of natural resources by individual countries cannot in the long run be inconsistent with world progress.

Although these principles sound extremely simple and obvious, the problem of their application is, in fact, very difficult. Determination of optimum use involves the weighing up of many, often conflicting, claims and there is very real danger that the conscious planning of land use, to which we are definitely committed in this country, may completely fail in its objective of improving our standard of living. Despite the existence of a Ministry of Town and Country Planning charged with the task of coordinating competing demands of land, our planners tend each to urge his own particular aim. Housing schemes conflict with food production; security needs conflict with amenity interests, and much that we are doing may well have to be undone if chaos is not to result.

Rural Population Densities and Rural Planning

In a country such as Britain we stand in the supremely dangerous position that long-range plans may be formulated and our destiny marked out for many years to come without an adequate foundation of factual knowledge and scientific interpretation. This is well illustrated by the present chaotic state of "rural planning".

It would seem obvious that, if every acre of good agricultural land is important in food production, new building in the countryside—in villages and the open country—should be restricted to building for agricultural purposes, including, of course, homes for agricultural workers. To avoid "pepperpot" and "ribbon" development, and at the same time to facilitate provision of essential services, such as electricity, piped water and main drainage, new building should obviously be in existing villages. Let us see where these two, apparently obvious, principles may lead us.

The population of rural areas falls into three main groups:

1. *The Primary Rural Population* of farmers, farm workers and their families with, in appropriate areas, forest workers—the people who depend primarily and directly on the land for a livelihood.
2. *The Secondary Rural Population,* which exists to serve the primary population and so to complete the essential make-up of the rural community. To be included are resident landlords, village shopkeepers, smiths, wheelwrights, workers in garages and servicing stations, certain of the middlemen serving rural needs, contractors for agricultual operations, together with the parson, publican, doctor, vet, school-teachers and postmen essential to village life.

3. *The Adventitious Population,* people who live in the country by choice. Included are many who have retired from active life from the country itself (retired farmers), from the towns or from abroad, but also many who, whilst working in nearby towns, prefer to live, and especially for their families to live, in rural surroundings.

Since the Primary and Secondary Rural Populations depend essentially on the capacity of the land to support them, the first question to be answered is how many farmers can the land support? Figures for farmers in Census and Agricultural Returns must be used with caution because of the inclusion, especially in the latter, of many smallholdings worked as a hobby, or part-time occupation, or to supplement a pension, by those who are not primarily farmers. For the first time, the 1941 Farm Survey gave basic data for England and Wales on *full-time farmers.* They numbered 215,900, and they were cultivating 21,296,000 acres of crops and grass or 88 per cent of the total cultivated area. Incidentally, this number of full-time farmers coincides very closely with the total number of holdings of over 20 acres. We get the important result that the average holding of the full-time farmer is 98.6 acres of crops and grass. The Farm Survey considered 10 acres of rough grazing as equivalent to one acre of improved grass, so that if the 5,600,000 acres of rough grazing were included we find that an "average" full-time farm in England and Wales is just over 100 adjusted acres. Thus over a typical stretch of, say, the Midlands of England, where nearly all the land is cultivated, there would be an average of rather over six farms per square mile worked as full-time holdings. Despite the many other changes which have taken place in British farming, there is abundant evidence to show that this position has not materially changed over the past eighty years. The number of holdings over 20 acres has remained almost constant (the drop from 212,041 in 1885 to 206,373 in 1945 is easily explained by diminution in total farmed area) and, contrary to popular belief, there has been no tendency to consolidate holdings into large units of over 300 acres (instead the number has dropped from 16,608 in 1885 to 12,360 in 1945). The "family farm" of 50 to 300 acres has become more firmly established than ever as the predominant unit.

The density of *farmers* per square mile has thus remained virtually unchanged, but their families are smaller than they were. Though the difference in the country is not as great as in the towns, in 1871 the total rural population was 3.76 times the number of males over 21, compared with 3.15 in 1931. Using these multipliers, we get a density of about 24 per square mile of farmers and their families in 1871, compared with about 20 at the present day.

With farm workers the position is completely different. In 1871 there were 675,768 farm workers in England and Wales over 20 years of age. This is an average of rather over 3 per full-time farmer, or one worker per 35 acres of crops and grass, or about 18 per square mile. Using the multiplier of 3.76, we get 68 per square mile of farm workers and their families. We have corresponding figures from the Census of 1931 of 383,359 farm workers, or 1.73 per farmer, or one per 60 acres of crops and grass, or 10 per square mile. This gives a density of about 32 per square mile of farm workers and their families in 1931. Whilst exactly comparable figures are not available for later years, the numbers of adult male workers dropped sharply from 1931 to 1939, and we may be sure that the present density of workers and their families does not exceed 30.

Summarizing, we find the *Primary Rural Population* was:

92 per square mile of cultivated land (crops and grass) in 1871.
50 per square mile of cultivated land (crops and grass) in 1941.

It is more difficult to calculate the *Secondary Rural Population*. A house-to-house survey of a number of rural parishes in Dorset carried out by Mr. Geoffrey Clark shows a Secondary Rural Population rather less than the Primary. This accords closely with the results obtained by Professor Alexander Stevens (¹) who, using an entirely different method of calculation, finds the total "landward population" (i.e., Primary plus Secondary Rural) rather less than double the Primary. For two purely rural counties, Huntingdonshire and Brecknockshire, he finds the multiplier is 1.77 and, in his words, "it seems a fair conclusion that if the value (of the multiplier) differs much from 2 for any community, some special reason must be sought, and will be found, to account for the fact".

Using these figures we thus get a normal rural population density not exceeding 100 per square mile of cultivated land in 1941 against one of 180 in 1871. This, it must be noted, is with the *same* number of farms and farmers and a considerably greater output, so that "rural depopulation" is linked with increasing agricultural efficiency.

It is instructive to see the relationship of these figures to the population of a typical English parish. By "typical" we are thinking still of the well-cultivated lowlands where the land is good but not superlative (2 plus 4 of the Land Classification 1 : 625,000 map). With village centres two miles apart, a large number of parishes approximate to 4 square miles or 2,560 acres. We see that the normal rural population at the present day is not likely to exceed 400*, although it was 720 in 1871. Now this has a very important bearing on the provision of social services and notably on educational facilities. I am indebted to my colleague Professor D. V. Glass for providing me with the following figures of school population in rural districts of England and Wales. In 1871, 23.8 per cent of the rural population fell into the age groups 5–14, i.e., of school age, or about 170 children in the parish of 720 souls, and of these about 80 were in the age group 5–9 for the village school. In 1931, 16.9 per cent fell into age groups 5–14, or about 68 in the same parish, and of these only 34 were of age 5–9 for the village school. If it is the policy of the Ministry of Education to eliminate single-teacher schools and to question the efficiency of even two-teacher schools, we seem to be approaching the day when there will be no rural school in the average village. But the same difficulties arise in the provision of other services.

In this address I am concerned to show deficiencies in our basic knowledge rather than to suggest the answers to such problems as the one just exposed, but one cannot help being forced to the conclusion that to maintain the whole social structure of rural Britain we must look to the "adventitious" population—that we should encourage those who wish to live in the country, whether they are actively engaged in work elsewhere or are retired. Their homes need not break up good farms and they must not detract from maximum food production, but to use the Development Charge or Planning consent to prevent their entry may be disastrous. A solution which has been proposed to some of the difficulties is to select "king villages" or "key" villages for development. Whilst this has some obvious points in its favour, it would be disastrous if it led to the decay of the non-selected villages, and might seriously hamper agriculture if workers or their wives and families—quite legitimately—preferred to live in the "king villages" far removed from their work.

* Incidentally these figures show that it is nonsense to talk about 600 or 1,000 population being a minimum for a "viable" village.

Lack of Knowledge Any such survey as that just outlined inevitably brings out a lack of knowledge of fundamental importance. It also brings out the failure of the specialist to appreciate the problems in another, though closely related, sphere. It often brings out, too, the failure either to apply knowledge already existing or to use the results already obtained by specialist investigators in another sphere. Particularly serious is the gulf between the natural scientist and the professional town and country planner. It is perhaps especially for the geographer, trained to appreciate, to correlate and to synthesize the results obtained in many realms of knowledge, to bridge this gap.

It may be worth while to indicate some of the more serious gaps in knowledge.

A working knowledge of elementary geology always seems to me an essential part of the mental equipment of any educated man, yet the ignorance not only of planners but often, I find, of other scientists is staggeringly abysmal. Failure to appreciate the disposition of economic minerals and the behaviour of underground water are two aspects of this ignorance which must affect the work of the planner. On the other hand, what really matters in a broad study of land use, possibilities of development and improvement of land is the surface geology. Yet over large areas in Britain the drift deposits remain unmapped, whether by amateurs, academic geologists or the Geological Survey. At a time when the working of gravels affects planning as well as agriculture in every county the lack of drift maps in so many areas is indeed a tragedy. Unfortunately we must accuse many geologists of a lack of interest in the economic aspects of their findings. The lithological characters of a gravel are what matter, together with thickness, variability, character of base deposit, and so on, in exploitation. Similarly the lithological characters and chemical composition of the deposits lumped as "Boulder clay" receive scant attention from the geologist.

We must pass over the lack of soil maps and of a comprehensive soil survey—a gap in factual knowledge so obvious as to speak for itself—whilst expressing an appreciation of the valiant efforts of the small band of workers in this field. Even here there is some lack of co-operation. The modern emphasis on the profile has tended to make some soil work less valuable to the agriculturist, who is concerned so largely with texture, than the older work such as that of our President, Sir John Russell, on the soils of Kent, Surrey and Sussex. Some soil scientists have contended that their work is purely objective and that the determination of a soil series does not give any indication of land quality. On the other hand, other soil scientists claim that their survey gives the whole answer to the problem of land classification.

A great need in this country is a comprehensive survey of water resources. For many years Captain W. N. McClean urged in vain before this Association the need for his pioneer work in river gauging to be continued and extended, and the present position in Britain remains chaotic—the criss-crossing of long distance supply lines; the ever-present threat to fertile farm lands suggested for reservoirs, whether by London or Leicester; and elsewhere, in strange contrast, the continued struggle to send water ever more easily and rapidly to the sea.

In meteorology and climatology the gaps in knowledge are especially in the realm of microclimatology. We know, empirically, that there are certain areas, often small, which are especially favoured by some such factor as free drainage of cold air in spring or a certain combination of slope, aspect, soil type and insolation and ought in any planning of land use to be reserved for agriculture, but there have been few exact surveys to help

the planner. Similarly the fact that the instruments in a Stevenson screen (over grass) are at such a height from the ground as to be *above* the level of growing crops and *below* the level of ripening tree-fruits, leaves an enormous field of detailed observation still needed by the agriculturist and so in the planning of land use.

Those concerned with the planning of land use are often puzzled by the attitude of the ecologist to a primary vegetation survey. The natural or semi-natural vegetation of those great problem lands of the country, the moorlands, heathlands and rough pastures, is said to indicate faithfully the sum total effect of environmental factors as stabilized by human activities, such as controlled grazing, yet no detailed maps are available in most areas.

I do not regard these indications of gaps in basic knowledge as more than samples: they are not given in any critical spirit of the work of the specialists in the field concerned but rather to indicate how, at present, the work of land use planning must rest on a scientifically unsatisfactory basis.

Survey of Existing Land Use It always seems to me obvious that the existing position must be the starting point for any future development. We must start from where we are. This was the basis of the work of the Land Utilisation Survey of Britain carried out in the years 1930–39 (mainly 1931–32), which aimed to record the then existing use of every acre of England, Wales and Scotland (and has since been extended to Northern Ireland). Land use in an old-settled country, such as Britain, is the result of many centuries of trial and error and of the interaction of many factors—natural or geographical, historical and economic. Existing land use has therefore a far deeper significance and is worthy of correspondingly more intensive study than in one of the newer countries of the world. Some of my scientific colleagues have urged that, before surveys of land use or any attempts at land classification are made, the *object* of the work should be known. I disagree. A survey of land use should be strictly objective and the results should be studied objectively. In the Land Utilisation Survey of Britain this has been done at length in the County Reports([2]) and in my own summary([3]), but three points may be emphasized.

In the first place, such a survey is a snapshot picture in a long process of evolution, and it is important to trace the history of land use. Cartographic comparison brings out the weakness of statistical comparison: the former tended to emphasize the remarkable stability over long periods of years of the land use pattern, contrary to the large changes suggested by the latter. Remarkably little change on the poorest lands and the best lands, the maximum of change on land of intermediate quality is the answer to the apparent contradiction.

In the second place, we may stress the importance of correlation—with solid and drift geology, relief, soils, and climate—which brings out the *increasing* influence of the geographical factors. This is a point I first emphasized at the Nottingham meeting of this Association as being contrary to accepted ideas. In general, with increase of facilities for transport and the development of world trade, geographical conditions must be favourable to secure economic development of land use—as in the cultivation of some specific crop against competition from elsewhere.

In the third place, the separation of the influence of the various geographical, historical and economic factors and the recognition of their continuing influence suggest trends in development. Land use planning becomes, in effect, the encouragement of trends deemed desirable and the conscious attempt to reverse those considered undesirable.

Land Classification In the preceding sections we have talked about an "average" farm on "average" land. Actually few if any countries of comparable size can boast such a wide range as can Britain in scenery or type and quality of land. We may claim that some of our brickearth soils are unsurpassed in natural qualities by any in the world and that this, combined with a climate which for certain purposes is also unrivalled, gives a level of production of a very high order. Such soils are strictly limited in extent and correspondingly precious. Unfortunately some professional town planners have such a pathetically touching belief in the powers of science and scientists that they believe almost any land can be treated and upgraded to this level and that they are free therefore to ignore quality of land. When the Government declared its intention of conserving good agricultural land it became suddenly necessary not only to define different types of land but also to map them. The simple classification into ten types which was developed has been the subject of much discussion which I have published elsewhere in full ([3]). Although Types 1 to 4 inclusive are the "good" agricultural lands, it must be emphasized that the ten are *types* and that it is not a question of No. 1 the best, and No. 10 the poorest. For certain purposes No. 1 is first class, for other purposes No. 3. For the sake of completeness Table 1 is included to show the area each type covers in England, Wales and Scotland.

This scheme of land classification has more than once been misrepresented. It is based essentially on the *unalterable* factors of elevation, slope, aspect, subsoil and drainage of the land and on the depth, profile and texture of the soil. There are some town planners who will not recognize the permanence of these factors and talk loosely about improving or upgrading land as if large areas could be transferred from one category to another. By lowering the water-table, land can be transformed from Type 3 to Type 1; light soils may be marled and heavy soils lightened by extensive dressing of sand, lime, etc.; but broadly speaking, any upgrading is an improvement of fertility status or productive capacity within the type.

Although in such an old-settled land as Britain there is an obvious correlation between land type and land use, it must be emphasized that the classification is not one based on *actual* land use but is related to potential use.

Apart from this correlation with land use, some interesting comparisons can be made with other types of distribution. The Land Classification map obviously reflects closely the major relief of the land and the solid geology. Other features are associated with such adverse hydrological conditions as bad drainage on peneplaned surfaces and excessive rainfall. But there is also a close tie-up with Types of Farming as shown on the map prepared by the economists of the Ministry of Agriculture.

Many data of immense interest were collected by the 1941 Farm Survey. The results have been analysed statistically, but only to a limited extent geographically. As part of the work of the Survey, the bounds of every farm were recorded on 25-inch, 12½-inch, or 6-inch maps. To transfer these boundaries to smaller scale maps is a colossal task, but where it has been done* the results are interesting in the extreme. Around nearly every village one finds smallholdings and little patches of accommodation land, but in the open country the farms worked by full-time farmers reflect almost everywhere the quality of the land. The poorer the land, the larger the holding needed for the family farmer to make a living. On the finest market-gardening soils of Evesham 10 or even 8 acres are enough

* By the Agricultural Land Service of the Ministry of Agriculture—at present confidential.

TABLE 1. CLASSIFICATION OF LAND IN GREAT BRITAIN

Type of Land	England and Wales		Scotland		Great Britain	
	Acreage	Percentage	Acreage	Percentage	Acreage	Percentage
Major Category I—Good	**17,845,900**	**47.9**	**3,963,300**	**20.8**	**21,809,200**	**38.7**
1. First class	1,963,100	5.3	396,800	2.1	2,359,900	4.2
2. Good general purpose farmland:						
2 (A). Suitable for ploughing	7,065,600	18.9	1,735,900	9.1	8,801,500	15.6
2 (AG). Crops or grass	2,636,900	7.1	192,900	1.0	2,829,800	5.0
3. First class, restricted use unsuitable for ploughing	1,234,800	3.3	8,700	0.0	1,243,500	2.2
4. Good but heavy land	4,945,500	13.3	1,629,000	8.6	6,574,500	11.7
Major Category II—Medium	**11,933,800**	**32.0**	**2,877,400**	**15.1**	**14,811,200**	**26.3**
5. Medium light land:						
5 (A). Suitable for ploughing	2,402,100	6.4	77,400	0.4	2,479,500	4.4
5 (G). Unsuitable for ploughing	220,300	0.6	300	0.0	220,600	0.4
6. Medium general purpose farmland	9,311,400	25.0	2,799,700	14.7	12,111,100	21.5
Major Category III—Poor	**6,350,900**	**17.0**	**12,113,800**	**63.5**	**18,464,700**	**32.8**
7. Poor heavy land	825,900	2.2	54,100	0.3	880,000	1.6
8. Poor mountain and moorland	4,516,800	12.1	12,001,700	62.9	16,518,500	29.3
9. Poor light land	811,800	2.2	57,900	0.3	869,700	1.5
10. Poorest land	196,400	0.5	100	0.0	196,500	0.4
Residue—closely built over	**1,142,700**	**3.1**	**114,200**	**0.6**	**1,256,900**	**2.2**
Total	**37,273,300**	**100.0**	**19,068,700**	**100.0**	**56,342,000**	**100.0**

The figures for England and Wales include the Isle of Man.

for a full-time holding, and where the holdings are large on such land they are either worked far below the level of their capacity or adequately with the aid of a large labour force. At the other extreme in the Welsh uplands the place of the standard 100-acre farm is taken by one of 10 acres of crops and grass with 900 acres of rough grazing. This "carrying capacity" of land is also linked up with the size of parishes. Obviously there are many exceptions, but in general the poorer the land the larger the parish, so that the parish populations in the very large scattered communities often approximate to figures already given. In such cases distance between settlements is an added difficulty in rural planning.

Data have been accumulated, but not yet worked out, showing a linkage between farm rentals and land quality. But, as I have indicated elsewhere, the correlation is not a simple or direct one([3]).

The Land Classification map of Britain obviously gives but a crude and highly generalized picture. But it *does* serve to indicate the small extent of the good lands and points to the tracts which should be avoided in the siting of new towns if the country's productive capacity is not to be impaired. In more detail the application and refinement of this method is being used to indicate the directions in which a given town may expand with least damage to productive capacity.

It will be noted that I use the words "productive capacity" and not production. So many town planners insist on using only existing production from what may be a badly farmed area to minimize their estimate of loss incurred by the schemes of urban expansion they may be advocating. Thus 50 acres of well-managed land of Type 3 will support a dairy herd of fifteen 1,000-gallon cows, giving a yield of 30,000 gallons a year per 100 acres. This is not the actual yield of the 1,243,500 acres of Type 3 land shown on the map, but if we are minded to indulge in calculation and speculation we can gain a glimpse of the country's productive capacity.

Two Settlement Patterns Britain has two distinct settlement patterns one imposed on another. The firmly entrenched rural social structure of landlord, tenant-farmer, and farm worker persists despite the increase in numbers of owner-occupiers and the waning fortunes of the harassed landowner. It has resulted in the extremely widespread pattern of "average" farms with farmsteads conveniently placed for each holding and so scattered. Some of the farms have tied cottages for workers, but the remaining population of the parish is grouped in one nucleus (nucleated village) or several (hamlets). The squire's house (if with a large park usually on the poorest land), the church, rectory, inn and stores form the basis of the village, together with the cottages of the agricultural workers and secondary rural population. Where water supply is a problem or defence formerly was, the farmsteads themselves may be in the village. A group of villages needed a market, hence the market towns originally so spaced as to be within reach on foot for man and beast. The development of roads and improved transport at once explain the growth of the better placed market towns and the decay of the remainder. Our medieval ancestors were wise: they knew their sustenance came from the soil and they did not cover valuable land with buildings. Thus the early manufacturing towns, supplying the needs of the countryside, often grew up, as Birmingham did, on tracts of unproductive land.

Superimposed on this still existing rural pattern is the pattern of modern industrial-commercial Britain. In the great growth following the Industrial Revolution the urban spread was mainly on the coalfields and for the greater part on poor land—Sheffield, Leeds–Bradford, Manchester with

TABLE 2. POSSIBLE CHANGES IN LAND USE IN GREAT BRITAIN

Pre-war Land Use: Acreage	Pre-war Land Use: Use	Pre-war Land Use: Percentage	Possible Change	New Percentage		New Acreage	Use
1,000,000	Arable—intensive (market gardening)	2.0	→No change	2.0	5.0	2,820,000	Arable—intensive
			→Arable—intensive	3.0			
11,069,400	Arable—farm crops	20.0	→Arable—farm crops	14.5	27.5	15,500,000	Arable—farm crops
			→Orchards and fruit	1.0	1.5	845,000	Orchards and fruit
261,300	Orchards and fruit	0.5	→No change	0.5			
			→Arable—farm crops	10.0			
18,897,500	Permanent grassland	33.0	→Grassland	22.0	25.0	14,100,000	Grassland
			→Arable—farm crops	3.0			
			→Grassland	3.0			
18,775,200	Heathland, moorland and rough grazing	33.0	→No change—rough grazing, sporting, national parks	15.0	15.0	8,450,000	Heathland, moorland, rough grazing
			→Forest and woodland	10.0	16.0	9,000,000	Forest and woodland
3,219,200	Forest and woodland	6.0					
	High forest (3.0)		→No change	4.0			
	Coppice (1.0)		→Coppice	1.0			
	Scrub and uneconomic (2.0)		→Uneconomic	1.0			
1,719,900	Houses with gardens including allotments	3.0		6.0	6.0	3,380,000	Houses with gardens
1,399,200	Land agriculturally unproductive, including airfields, training grounds, etc.	2.5		4.0	4.0	2,246,700	
56,341,700		100.0		100.0	100.0	56,341,700	

The acreages on the left are those calculated from the Land Utilisation maps, and include ponds and other small areas of inland water. Figures include the Isle of Man.

Ashton, Bolton, Bury, Rochdale, the Black Country and the Welsh valleys are all good examples. Though the working of the deeper parts of the coalfields affected good land, it is the partial emancipation of industry from the coalfields by use of electricity which has provided a major threat to the continued existence of the best food-producing lands. This threat is reinforced by the timidity of town planners or parsimony of central and local authorities in seeking level or near level sites. It seems to be accepted far too widely that a satisfactory new town or housing estate depends primarily on more space, ignoring the fact that the majority of our beautiful towns and cities owe much to an intelligent use of varied, often difficult, natural sites.

The two settlement patterns are superimposed rather than fused and the question arises: how far are their established features permanent?

It has already been pointed out there has been remarkably little change over the past eighty years in numbers of farms and consequently of their size. Are changes likely in the foreseeable future? Since it seems that the world trend in farming is towards the British model of the mixed family farm, cultivation-machinery is more likely to be adapted to British needs than British farms reorganized to use large-scale American machinery designed for the already obsolescent prairie type of monoculture. If adjoining British farms are more economically worked as larger units, redundant farmhouses will become country residences or homes for foremen. But any such tendency to amalgamation is offset by the deliberate creation of statutory smallholdings on which selected nominees can learn the business of farming. The suggestion therefore is that the overall rural pattern will remain.

Except for certain areas of land reclamation such as around the Wash or areas marked out for specialized agricultural development such as Romney Marsh, it should be noted that the rural pattern is complete over the country. Farms may be realigned, villages strengthened by additional cottages, market towns revivified by industry, but there is no room for new villages or new towns as part of the rural pattern.

Not so the urban pattern. Seemingly oblivious to the fact that the land area is fixed and inextensible at 37 million acres for England and Wales and 19 million for Scotland—if we ignore small extensions possible by expensive reclamation of tidal flats—demands upon land become ever more extravagant. In place of the Victorian industrial towns with 64 houses to the acre, town planners now demand an acre for 8 or 10 houses. The standards for the new towns, taken over all, are one acre per ten *persons*, so that 6,000 acres are demanded for a town planned for 60,000. In 1925 one-tenth of the surface of England and Wales, according to the Scott Report, was "developed" for towns, villages, roads, etc. *The Times* has calculated that if the present trend continues 15 per cent will be so used by 1962 or 1967. Since towns cannot be built on mountain tops it becomes more realist if we say this is nearly a quarter of all the farmland of the country. In the words of Lord Radnor, we seem to be heading for "new towns to starve in," for we must remember that every 1,000 acres of average land taken robs 1,790 people of their share in the food-producing land of the home country.

If we turn back to the Table of land classification we see that land of medium and poor quality covers more than half the country and that, avoiding the obviously unsuitable areas, there is room both for the proper re-housing of our people and the maintenance of home food production—or at least the conservation of the land for that purpose. I see no reason to revise seriously a calculation I made some years ago of actual and potential use of the land of Britain (Table 2).

But this is a glimpse of speculation into the future, and my main aim in this address has been to appeal for a detached scientific approach to the work of the planning of land use.

Reproduced by courtesy of the British Association for the Advancement of Science.

References

1. The Distribution of Rural Population in Great Britain. *Trans. and Papers of the Institute of British Geographers* (1946), **11**, 21.
2. The Land of Britain: The Report of the Land Utilisation Survey. Edited by L. D. Stamp. Geographical Publications Ltd.
3. The Land of Britain: Its Use and Misuse (1948). L. D. Stamp. Longmans. 42s.

NEW SWEET CORN FROM AMERICA

GORDON HASKELL

John Innes Horticultural Institution, Merton Park

THE demand for early sweet corn of good quality to supplement ordinary vegetables is steadily increasing in England, though ten years ago its use was quite a novelty. Nowadays, many of the better class greengrocers stock it during the summer months, and some of the larger hotels place contracts for the delivery of fresh sweet corn ears.

In this country we require strains that have good germinating ability in the early spring and which come to early harvest ; they must also give high yields of marketable ears. For the last ten years, plant breeders, although often interrupted by war-time problems, have been attempting to improve the sweet corn plant with these aims in view.

Obtaining New Strains Through a grant from the Agricultural Research Council, the writer was able recently to spend a year in the U.S.A. studying the latest maize and sweet corn breeding methods. Visits were made to various states to consult plant breeders about the most suitable varieties to bring back to England for testing under our conditions.

After a careful study of the many strains, during which English climatic conditions were kept in mind, several hundred were brought back. Nearly all were of the yellow-seeded types, as white sweet corn is no longer used in America. The strains were of two genetic kinds: (1) open-pollinated varieties which had been selected by American commercial plant breeders primarily for early maturity and production of quality ears, and (2) hybrids which have been bred both by commercial firms and by geneticists at the State and Federal Experiment Stations for earliness and uniformity of plant and ear characters and high yield.

Hybrid sweet corns differ from open-pollinated varieties not only in the way they have been bred but also in their comparative uniformity. By artificially self-pollinating sweet corn, generations are obtained which are much depressed compared with the variety from which they were obtained. Yet from careful selection of these "inbred lines" breeders have obtained some that are strong enough to use as parents. The plants within each inbred line are remarkably uniform. Inbreds of different maturity can be so obtained, some very early, some medium early and some late. When certain

inbreds are pollinated by other inbreds derived from different open-pollinated varieties, hybrid seed is obtained, and plants from these show good hybrid vigour. By selecting out and cross-pollinating the combinations of two inbreds most suitable for particular purposes, American breeders have been able to raise a wide range of vigorous hybrid sweet corns of different seasonal maturity and for different markets. There is also a range to satisfy the market growers who like to have a choice of strain.

Variety Trial at Merton, 1948 In 1948 an experimental plot was laid down at Merton, but the area available enabled us to test only 80 strains. Reduction to this number meant that strains included in the trial were ruthlessly selected on the basis of their record in North America. This explains why some varieties already known in England, e.g., Golden Sunrise, are absent from the Table. Three strains previously grown and found suitable for English conditions were used as controls. These were Extra Early Bantam, John Innes Hybrid No. 1, and Canada Gold. All the seed, except some from research stations, had been dusted with a protectant to keep down fungal attacks. The experimental block was divided into two plots, each consisting of 80 rows running north and south. Forty seeds of each strain were used for each row, except for Commando, Nuetta and a Spancross line (854.3 × 12), of which only twenty seeds were sown singly. Shallow rows were marked out, and on May 13, 1948, two seeds dropped in them at intervals of 1 foot. The seeds were then lightly covered with soil.

The position of a variety in each plot was previously determined by means of randomized tables of numbers so that no preference was given to the position of any variety in either plot. The soil of the experimental plots was a light sandy loam. It had received fertilizers the previous year, and was known to be high in nitrates and phosphates, thus no fertilizers were given during 1948.

When the seedlings had developed their first leaves, they were thinned out to one per "hill," selection being made by removal of those out of line, rather than by roguing weaker seedlings. Damage by frit fly was very severe and records were made of the severity with which each variety was attacked in both plots. In general, some strains like Northern Cross were more resistant to frit fly and showed less signs of damage than others, but none escaped attack completely.

Explanation of the Table The results given in the Table on pp. 413–5 were obtained as follows. The records of each strain from each plot were taken separately and averaged (given in the Table). The rows were carefully observed until they were judged individually to be ready for harvesting. There was only one picking of ears in each row, and they were harvested when the majority of first ears on main stems were at the milky stage. In some strains, ears on the tillers could also be picked. The first strains harvested were the Spancross lines bred by Dr. W. R. Singleton. These were picked on August 30, 1948 ; all other harvest dates in the Table are measured from this date. The strains are presented in order of earliness, since in England earliness is of first importance.

The percentage stand represents the mean number of plants that remained after thinning, but not at maturity, expressed as a percentage of *half* the number of seeds sown ; this is similar to the percentage germination. The mean number of marketable ears per plant and their mean weights, i.e., individual plant yields, were calculated for each strain. The yield per acre in number and weight of marketable ears was then estimated.

Some of the ears picked were not suitable for market. The column showing the proportion of marketable ears to the total number picked gives a general idea of crop uniformity, e.g., 1.0 indicates that all ears were marketable, while 0.5 indicates that only half were. The next column shows the most frequent row number in a sample of ten ears. This is useful to know, since the twelve-rowed strains of sweet corn are preferred for domestic use; eight-rowed types are no longer popular. The quality of the raw ears was determined in the field ; often the more tender ears were also the sweeter. At the present stage of sweet corn usage in this country, all were far superior to the flint corns which unfortunately are often sold as sweet corn. Ears picked at the optimum condition and cooked for ten minutes soften considerably, and are thus more tender than when judged raw. The final column in the Table gives some brief comments, made from yield observations, on plant characters, uniformity and resistance to disease.

The Best Hybrids and Varieties Although some of Dr. Singleton's hybrids, involving inbreds C3, C8, and C12, were very early, their estimated yields of marketable ears were low. Extra Early Bantam is still one of the earliest sweet corn strains for this country, and it also yields well in terms of the number of marketable ears per acre. It is followed by (Seneca 60 × C13) and John Innes Hybrid No. 1, both early and higher yielding. If, however, a heavy yielding strain is required, even though maturing rather later, Northern Cross is recommended. It outstripped all others for yield and plant characters, such as uniformity and frit fly resistance ; the ears, as shown in the illustration (p. iv of art inset), were of good uniform appearance, but the quality was not so good as strains from Canada. It is hoped to re-test this and other promising hybrids to see whether they can be sown earlier and therefore harvested sooner. The excellent germination of Northern Cross indicated that it might be cold-hardy to English soil conditions.

It will be seen that some of the later varieties do not necessarily produce higher yields of marketable ears, although two unnamed Connecticut hybrids, namely, (C37.30 × 1184) and (C40 × 1184), both yielded well : Golden Security also yielded well, although this was far too late. Golden Cross Bantam, which is the most popular hybrid in the U.S.A., was too late to be satisfactory for use in England. However, some of the very late varieties and hybrids made vigorous uniform plants with good plant characters. Their tissues are sweet and succulent and therefore these plants might be tested to see if they could be used for fodder or silage, like the white horse-tooth maize grown in some parts of England, but in any case dollar scarcity militates against the import of sweet corn at the moment.

It is still too early to say which of the inbreds brought over from America might be grown successfully for hybrid seed in this country. It is likely that only those produced by State Experiment Stations could be used, since those that are copyright by American seed firms would probably not be available unless grown under special licence.

The Table shows for the first time the behaviour over here of a large number of leading strains that had been *carefully chosen for this trial.* It is hoped that importers will modify their stocks to the more satisfactory modern types of sweet corn hybrids when restrictions on seed imports are relaxed.

Thanks are due to all the commercial firms and research workers who so generously provided material for testing in England.

SWEET CORN TRIALS: 1948

Sown on May 13, 1948, at the John Innes Horticultural Institution, Merton Park

Strains: Variety or Hybrid (*)	Source of Seed	Earliness (days after Aug. 3)	Stand	Estimated Yield per Acre		Proportion of Marketable Ears to Total Number Harvested	Most Frequent Seed Row Number on Ears	Raw Ear Quality		Comments
				No. of marketable ears in thousands	Weight of marketable ears in 1000 lb.			Tenderness	Flavour	
			per cent							
*(C3 × C12)	Connecticut A.E.S.	0	80	8.7	8.3	0.7	12	Fair	Fair	Highly recommended.
*(C3.857-38 × C12)	Connecticut A.E.S.	0	90	8.2	9.7	0.6	12	Tough	—	Reasonably uniform.
*(C8 × C12)	Connecticut A.E.S.	4	50	4.4	5.0	0.7	8	—	Fair	Rather irregular; good plants.
*(C3.857-38 × C13)	Connecticut A.E.S.	4	78	3.9	5.4	0.6	12	Tough	Poor	Slightly irregular.
*(854.3 × 12)	Connecticut A.E.S.	5	88	8.2	11.4	0.3	12	Tough	Poor	Uniform; good tall plants.
*Ottawa Hybrid CH_2	Cent. Exp. Farm, Ottawa	5	78	4.9	6.5	0.7	10–12	Tough	—	Poor plants; frit fly damage.
Extra Early Bantam	Harris, N.Y.	7	80	17.4	6.8	0.9	8	Tough	Fair	Good plants; slightly irregular. Recommended.
*(Seneca 60 × C13)	Robson, N.Y.	7	78	14.2	7.9	0.9	10	—	Poor	Rather short plants.
*Sugar and Gold	Eastern States, Mass.	7	78	11.3	8.8	0.8	12	Tough	Poor	Sun-red plants, i.e., reddish leaves.
Golden Rocket	Robson, N.Y.	7	40	7.7	4.6	0.7	12	Soft	Sweet	Plants somewhat irregular.
*Seneca 60 Hybrid	Robson, N.Y.	7	70	7.0	6.4	0.8	8	Tough	Good	Irregular plants.
Sugar Prince	Cent. Exp. Farm, Ottawa	7	55	6.6	6.7	0.7	12	Tough	Poor	Generally poor plants.
Orchid Baby	Will, N.D.	7	55	4.3	1.9	1.0	irreg.	—	Good	Plants too small; useless.
*John Innes Hybrid No. 1	John Innes, Merton	11	83	13.7	8.2	0.9	10	Rather tough	Fair	Good plants; slightly irregular. Recommended.
North Star	Harris, N.Y.	11	85	12.0	9.7	0.7	12	Fair	Fair	Rather irregular, short plants.
*Ottawa Hybrid CH1	Cent. Exp. Farm, Ottawa	11	88	10.9	8.3	0.9	8	Very soft	Poor	Regular, good plants; dark green. Recommended.
Early Saskatchewan	Burgess, Mich.	11	65	6.0	5.6	0.8	8	Tough	Fair	Generally poor.
Early Golden Sweet	Gill, Or.	11	43	0.3	3.2	0.5	irreg.	—	—	Badly damaged by frit fly and smut.
Dorinny	Cent. Exp. Farm, Ottawa	14	50	7.0	3.0	1.0	—	Medium tough	Sweet	Fairly uniform; striped leaves. Too short.
Early Golden Market	Gill, Or.	14	50	6.5	5.6	0.8	10–irreg.	Soft	Very good	Generally poor plants.
*Northern Cross	Harris, N.Y.	15	100	41.4	11.2	0.9	12	Tough	Fair	Highly recommended; uniform.
Alpine Bantam (Flint)	Michael-Leonard, Ill.	15	85	16.5	7.0	0.9	irreg.	Tough	Poor	Not a real sweet corn.
Canada Gold	John Innes, 1943	15	65	14.7	6.6	0.8	8	Tender	Fair	Plants irregular.
*Seneca Dawn Hybrid	Robson, N.Y.	15	50	12.5	6.7	0.8	irreg.	Tough	Poor	Irregular and poor plants.
*Spancross	F. H. Woodruff, Conn.	15	55	12.0	6.0	0.9	12	Tough	Fair	Rather irregular; badly damaged by frit fly.
*Surprise Hybrid	Vaughan, Ill.	15	53	10.3	4.9	0.7	12	Good	Good	Generally poor; attacked by smut.

Continued

Continued

Strains: Variety or Hybrid (*)	Source of Seed	Earliness (days after Aug. 30)	Stand	Estimated Yield per Acre		Proportion of Marketable Ears to Total Number Harvested	Most Frequent Seed Row Number on Ears	Raw Ear Quality		Comments
				No. of marketable ears in thousands	Weight of marketable ears in 1000 lb.			Tenderness	Flavour	
			per cent							
*(Merton 127 × C17-1) ..	Connecticut A.E.S. ..	15	60	9.8	7.0	0.8	14	Rather tough	Fair	Regular, good plants.
Alphagold Bantam ..	Michael-Leonard, Ill. ..	15	60	7.1	6.5	0.8	12	Tender	Poor	Irregular and weak plants.
Alpha	Ferry-Morse, Mich. ..	15	43	4.9	3.7	0.7	8	Tough	Poor	Poor plants and ears; segregates white seed.
*Goldban	Cent. Exp. Farm, Ottawa	15	40	4.4	2.4	0.8	8	Delicate	Very sweet	Irregular, small plants.
*Seneca Golden Hybrid ..	Robson, N.Y.	18	85	19.6	9.8	0.7	12	Tender	Sweet	Slightly irregular plants; fasciated tips on some ears.
Earliest Golden	Burgess, Mich.	18	88	17.9	11.0	0.8	12	Tough	Sweet	Plants irregular.
*Cornelis' Goldrush Hybrid	Park, S.C.	18	78	17.9	10.4	0.8	12	Tough	Fair	Plants irregular.
*(Merton 127 × Golden Midget)	Connecticut A.E.S. ..	18	95	15.3	10.5	1.0	12	—	Fair	Uniform, good plants and ears.
*(C40 × C17-1)	Connecticut A.E.S. ..	18	85	14.1	8.3	0.7	12	Very fair	Fair	Slightly irregular plants.
*Hybrid Golden Hummer ..	Michael-Leonard, Ill. ..	18	65	13.0	6.5	0.6	12	Tough	Poor	Fairly uniform and short plants. Good ears.
Earliest Golden	Vaughan, Ill.	18	70	11.8	9.4	0.9	10	—	Sweet	Irregular, small, bushy plants.
Commando	Will, N.D.	18	95	9.7	10.4	1.0	10	Fairly soft	Distinctive taste	Generally very poor plants and ears.
*Our Choice Hybrid ..	Vaughan, Ill.	21	83	19.6	9.9	0.9	12	Tough	Poor	Irregular plants; good ears.
*Marcross	F. H. Woodruff, Conn. ..	21	68	11.6	8.0	0.5	12	Tough	Fair	Good, fairly uniform plants; rather short. Good ears.
*Midgolden Hybrid.. ..	F. H. Woodruff, Conn. ..	22	85	14.6	9.5	0.5	10	Tender	Fair	Irregular plants; good ears.
New Golden Gem	Shumway, Ill.	22	63	12.0	7.1	0.7	12	Medium tender	Poor	Plants generally small and irregular.
*60-Day Yellow Hybrid ..	Buist, Pa.	22	68	9.3	8.2	0.7	12	Tough	Poor	Uniform plants; good ears.
60-Day Early Yellow V. ..	Buist, Pa.	22	55	8.7	6.0	0.6	12	Tough	Fair	Plants short and irregular. Some smutty ears.
*Carmel Cross	F. H. Woodruff, Conn. ..	25	75	20.1	9.3	0.6	12	Tough	Sweet	Irregular plants; good ears.
*Wisconsin 801B	Wisconsin, A.E.S. ..	25	88	16.6	7.4	0.8	8	Medium tender	Fair	Fairly uniform, tall plants; sun-red leaves.
The Burpee	Burpee, Pa.	25	80	16.4	10.4	0.7	18	Tough	Fair	Irregular plants; some ears abnormal.
*Mohican Gold Hybrid ..	Tristate, Pa.	25	75	8.7	10.1	0.4	12–14	Tough	Fair	Irregular plants; very long ears.
Golden 60-Day	Vaughan, Ill.	25	53	7.1	5.3	0.7	12	—	—	Rather short, irregular plants; short ears.
*Dorick Hybrid	Cent. Exp. Farm, Ottawa	25	60	6.0	6.4	0.5	—	Very tender	—	Small, irregular plants.
Nuetta	Will, N.D.	25	65	4.4	6.8	0.8	irreg.	—	—	Very poor plants and ears.
Early June	Will, N.D.	27	65	3.4	5.6	0.7	—	—	—	Very irregular plants.
*(C37.80 × 1184)	Connecticut, A.E.S. ..	28	88	27.9	8.7	0.7	irreg.	Tough	Fair	Irregular plants; some ears poorly pollinated.

*(C40 × 1184)	Connecticut, A.E.S.	28	70	26.7	7.9	0.7	12	Fairly soft	Fair	Uniform good plants.
*New Earligold Hybrid	F. H. Woodruff, Conn.	28	83	19.1	10.3	0.8	12	Medium tender	Poor	Irregular plants.
*Honey Cross	Stumpp and Water, N.Y.	28	80	18.0	9.2	0.8	12	Medium tender	Good	Irregular plants.
*Wisconsin 802D	Wisconsin, A.E.S.	28	83	15.8	8.8	0.7	8	Tender	Poor	Irregular plants.
*(1040 × C35)	Connecticut, A.E.S.	28	43	15.3	3.7	0.6	12	Very tender	Fair	Uniform, nice plants; leaves red; nice ears.
*Minhybrid 202	Farmer, Minn.	28	70	14.5	6.4	0.7	8	Tough	Fair	Irregular plants, nicely shaped ears.
*Sunlite Hybrid	Henderson, N.Y.	28	40	6.5	4.2	0.9	12	Tough	Poor	Irregular plants.
Golden Hummer V.	Michael-Leonard, Ill.	28	30	5.4	3.9	0.7	12	Tough	Poor	Irregular, poor plants.
Extra Early Golden	Comstock, Conn.	29	48	6.5	6.0	0.6	10–12–14	Tough	Poor	Highly irregular.
Tendermost	Gill, Or.	39	63	13.6	8.1	0.7	14	Medium tender	Fair	Short plants; good ears.
Tendergold	Michael-Leonard, Ill.	39	60	12.6	7.3	0.6	12	Tough	Fair	Fairly uniform plants.
*Improved Sencross	F. H. Woodruff, Conn.	40	93	26.2	12.2	0.7	12	Medium tough	Poor	Rather irregular plants; good ears.
Charlevoix	Ferry-Morse, Mich.	40	48	12.0	5.1	0.7	8–12–14	Fairly tender	Sweet	Good plants; good ears.
Golden Security	F. H. Woodruff, Conn.	50	95	35.4	10.8	0.8	14	Tough	Fair	Uniform plants and ears; perhaps useful for silage.
*Golden Cross Bantam	Robson, N.Y.	51	70	28.2	8.4	0.7	12	—	—	Uniform, dark green plants; good ears. ? for silage.
Iroquois Golden	Tristate, Pa.	51	95	26.7	6.5	0.7	16	Very tough	Fair	Large, uniform plants and ears; useful for silage.
*Cream of Gold Hybrid	Henderson, N.Y.	51	78	24.0	8.2	0.8	8	Tender	Sweet	Very large, tall, regular plants; good ears. ? for silage.
*Pioneer Hybrid	Pioneer Iowa	51	80	21.3	10.2	0.8	12	Medium tough	—	Perhaps useful as silage.
*Wisconsin 803	Wisconsin, A.E.S.	51	70	19.7	8.0	0.8	8	Tender	Sweet	Sturdy plants.
*Wisconsin 800A	Wisconsin, A.E.S.	51	73	18.5	7.3	0.9	8	Tender	Poor	Produces many tillers.
*(Seneca 92 × 28)	Robson, N.Y.	51	78	17.4	9.1	0.7	12	Tough	Poor	Uniform plants, perhaps useful as silage.
*Wisconsin 804C	Wisconsin, A.E.S.	51	50	17.4	5.3	0.7	10	Medium tender	Poor	Uniform, rather short plants; uniform ears.
Barden's Wonder Bantam	Michael-Leonard, Ill.	51	55	7.1	6.7	0.6	8	Tender	Fair	Plants and ears irregular.
*Snowcross (White)	Burpee, Pa.	51	53	15.2	6.1	0.5	14	Tough	Poor	White seeded. ? for silage.
Pickaninny	Cent. Exp. Farm, Ottawa	—	—	0	0	—	—	—	—	Yellow seeds, turn purple when ripe.
Mason's Golden Midget	Kennedy, N.Y.	—	—	0	0	—	—	—	—	Too small for commercial use.
*Earliest Pioneer Hybrid	Will, N.D.	—	—	0	0	—	—	—	—	All plants dwarf and smutty.

Strains underlined were used as controls. Those with asterisks are hybrids; the rest are varieties.

The assistance of Miss P. Dow in preparing this table is acknowledged.

SHEEP-GRAZING OF SEAWEED

OBSERVATIONS ON NORTH RONALDSHAY, ORKNEY IS.

D. E. Tribe

Rowett Research Institute, Bucksburn, Aberdeenshire

and

E. M. Tribe

North of Scotland College of Agriculture, Aberdeen

SEAWEED has long been used in many countries as a stock food. It has been reported that it is readily grazed by livestock in many northern European countries, in Lapland, and in the Faroe Islands (1). In an essay published in 1874, Pringle (2) included some notes on the management of the Orkney breed of sheep, which, he said, were kept on North Ronaldshay and fed on seaweed "of which they were very fond". In 1939 Scarth and Watt (3), when describing agricultural conditions in the Orkney Islands, again reported the consumption of seaweed by these sheep, which are still kept on the perimeter of North Ronaldshay, the most northerly isle of the Orkney group. They also pointed out that seaweed is eaten on the shores of Eynhallow, between Evie Parish and Rousay, where the sheep regularly seek the beach at ebb-tide, no matter how rich the grazing on land may be. This is not confined to the native breed, for Cheviots, put out on such islands for the summer, are observed eating seaweed within a few days of arrival.

Hendrick (4) was more detailed in his observations, made in the west of Lewis, the Hebridean island, and noticed that both cattle and sheep eat seaweed very readily, but that they are selective both in the species eaten and in the parts of an individual species eaten. Hercus (5) reported that sheep in South Otago show "a remarkable craving for seaweed," and suggested that this may be attributed to an iodine deficiency in their normal diet. Moore (6) has testified to the health of sheep and pigs which graze seaweed in New Zealand. When possible, sheep eat seaweed regularly and afterwards appear to be "bright and lively, and are generally in excellent condition".

However, although information has been collected in a variety of accurate laboratory trials concerning the extent to which seaweed, in the form of a dried meal, may be fed to the various classes of domestic stock (1, 7, 8, 9), very little is known of the circumstances accompanying the grazing by stock of seaweed in its natural environment. Only evidence of an anecdotal character has, so far, recorded the conditions surrounding the grazing of seaweed on the seashore, and even this is severely limited in quantity. It is clear that there is still much information required concerning the seaweed species and parts of species actually eaten by various classes of livestock and, also, the general condition of health of animals eating seaweed. A visit was therefore made to North Ronaldshay in the winter of 1948–49, and the following information is the result of repeated observations of the sheep's feeding habits at high- and low-tides, and of many discussions with local crofters.

Management, Breed, and Health of Sheep Before discussing in detail the species of seaweed eaten, it is necessary to describe briefly the type of sheep concerned, and the conditions of their management. A detailed description of the sheep husbandry has already been given (10).

Around the twelve-mile perimeter of the Island runs a dry stone dyke between six and eight feet high. With the exception of the first two months of lactation, the two thousand sheep are always kept on the outside of this barrier. During the initial stages of lactation, most of the ewes and lambs are folded or tethered on inland pastures, but, even at this time, an occasional ewe and lamb remains on the shore. Outside the stone dyke lies the foreshore, with its associated strips of permanent pasture. In 1874, however, Pringle (2) describes these pastures as "strips of waste land," and it is quite fair to say that the quantity of grass available from these sources could not appreciably affect the animals' diet. There was literally no grass available while we were on the Island, and we were assured that even in spring the amount is negligible; sheep patronize the patches only when an exceptionally high tide submerges other more popular parts of the shore. It is no exaggeration to say that the sheep are dependent on the seaweed for all their nutritional requirements.

The animals are never short of food. In the summer, ebb-tides expose acres of seaweed-covered rocks, and in the winter the storms wash the plants ashore by the ton. Probably these are the only sheep in Scotland which are better fed in winter than in summer. Since their food becomes available in greatest quantities during the winter storms, these sheep reach prime condition in December, and those slaughtered in winter give fat, well-balanced carcasses.

All the sheep belong to the native Orkney breed, which is probably the smallest and hardiest in Britain. An animal takes from three to four years to reach maturity, and even at this age an average wether gives a carcass weight of only 30 lb. The meat of these animals is darker than normal, and has a characteristic, but by no means unpleasant, flavour. The wool is said by the manufacturers to be warmer than any other, but the annual yield per animal is only two or three pounds. In trying to obtain bigger yields of meat and wool, crosses have been made between the Orkney ewes and Cheviot, Blackface, Border Leicester, and even Shetland, rams. None of these has been successful, however, since the resulting animals were unable to withstand successfully the exposure and rigours of the North Ronaldshay foreshore.

Although the mortality rate amongst these sheep is not low, the general health of the animals is excellent, the great proportion of the deaths being caused by drowning and exposure. Braxy is very uncommon; there are only isolated cases of gid, ticks are entirely absent, and there are few intestinal worms. Foot rot is never troublesome and, on the diet of seaweed there is no bloat. Scab is unknown, and in view of the peculiar circumstances of the Island, the dipping regulations have been waived.

Zoning of Seaweed Species The seaweed itself is distributed in the usual zones along the rocky shore. Along the upper limit of the high-tide mark the rocks are covered with a dense turf of Channelled Wrack (*Pelvetia caniculata*) and Flat Wrack (*Fucus spiralis*). According to figures quoted by Wilson (11)*, the plants at the top of this belt are exposed to the air for 80 or 90 per cent of the time, and at the bottom for 60 or 70 per cent. Below this belt is a broad zone consisting of Knotted Wrack (*Ascophyllum nodosum*) and Bladder Wrack (*Fucus vesiculosus*), which are present in very large quantities, and are exposed from 15 to 55 per cent of the time. At their lowest level they overlap another broad zone consisting of Serrated Wrack (*Fucus serratus*); this is

* In this connection this authority will be quoted throughout.

exposed in particularly large quantities at the spring low tides, and receives from 0 to 50 per cent exposure. Below this come the various species of the order *Laminariales*, which are exposed only at the very low tides, and then only for a short time. To this zonal distribution of growth, however, must be added the great stretch of shore above the high-tide mark which is covered by the hundreds of tons of tangle that are washed up every year by the storms. In some places this material lies as much as six feet thick and extends for two hundred yards along the shore. Its collection for the kelp industry used to be the main occupation of the Island's male population, but now the surplus left by the sheep merely lies rotting on the shore. Almost all of this tangle belongs to the *Laminariales*, the greater proportion being *Lamimaria digitata*.

The species actually available to the animal are, therefore, zoned as follows: *Laminaria* sp., *Pelvetia canaliculata* and *Fucus spiralis*, *Ascophyllum nodosum* and *Fucus vesiculosus*, *Fucus serratus*, and, nearest the water, *Laminaria* sp.

While the *Phaeophyceae* are undoubtedly the most important algae from a nutritional standpoint, there are a few *Chlorophyceae* and *Rhodophyceae* that must be mentioned. Of the green weeds, the only three that occur in appreciable quantities are *Ulva lattuca*, *Cladophora* sp., and *Enteromorpha* sp., which are distributed widely throughout the inter-tidal rock pools. The red weeds are more plentiful, and *Rhodymenia palmatta*, *Chondrus crispus*, *Gigartina mamillosa*, *Corallina officinalis*, and, of course, the *Polysiphonia* sp. that grow in abundance on the *Ascophyllum*, are all available to the sheep. Of these, all are commonly found in the inter-tidal pools, except *Rhodymenia palmatta*, which is seldom found growing except at very low tides; appreciable quantities of it are, however, thrown up on the stipes of the *Laminaria* sp.

Palatability Without a doubt the species most commonly eaten is *L. digitata*. This is surprising in view of the observations of Hendrick (4), who stated that neither sheep nor cattle ever ate it. It is an obvious peculiarity that the sheep prefer to eat the portion of the plant at the junction of the stipe and frond—in fact, just at the point where intercalary growth takes place. After this the complete frond is eaten, and many animals gnaw the stipes, which are often six feet long and as much as two inches in diameter. If the islanders ever have occasion to feed seaweed to an animal off the shore, it is *L. digitata* that they cart inland. Besides this species, *L. stenophylla*, *L. Cloustoni*, *L. saccharina*, and *L. hieroglyphica* are all common on the shore, and all eaten in quite large amounts in the same manner as *L. digitata*. *Alaria esculenta* is not so common as the others, but it is certainly equally popular and eaten on every possible occasion. *Chorda filum* is very scarce and, as far as was seen, is never eaten by the sheep.

Compared with the *Laminariales*, the *Fucales* are definitely unpalatable. The only species that are eaten readily are *Pelvetia canaliculata* and *Fucus spiralis*. The young and more tender branches of *Ascophyllum* and *F. vesiculosus* are nibbled, but these species, like *F. serratus*, are certainly not popular. *Himanthalia lorea* and *Halidrys siliquosa* are very uncommon, and it is doubtful whether they are ever eaten.

The red weeds probably include the most palatable species of all, but since they are not present in very large quantities their dietary significance is small. Dulse (*Rhodymenia palmatta*) is the most palatable of all the weeds, and when washed ashore attached to the stipes of the *Laminaria* sp. it is eagerly nibbled off. Irish or Icelandic Moss (*Chondrus crispus*) comes

next, and this, together with Carragheen (*Gigartina mamillosa*), is eaten at every available opportunity. Both these species, however, occur most commonly in the rock pools exposed at low tide, and the sheep will never put their mouths in the salt water to reach even the most palatable of plants. *Polysiphonia* is the only other red weed that is eaten in appreciable quantities; while nibbling the young shoots of *Ascophyllum*, the sheep will eat the associated *Polysiphonia*, and they were observed to eat this without, at the same time, taking the *Ascophyllum*.

It is worth while noting that there is an apparent correlation between these observations on the palatability of the species and those previously reported on their nutritive values. In 1939 Ringen ([9]) published the results of a series of seaweed digestibility experiments with sheep and pigs which showed that *Fucus vesiculosus* was less digestible than *Laminaria*. Senior, Collins, and Kelly ([7]) confirmed this finding in some further digestibility trials with sheep. These workers found that *L. stenophylla* and *L. digitata* were distinctly more digestible than *F. vesiculosus* and *F. serratus*, although only slightly more digestible than *Ascophyllum nodosium*.

From a nutritional aspect the fauna associated with the seaweed must be of importance, and it is probable that a variety of small animals and snails are swallowed daily. On many occasions we saw *Laminaria* fronds being eaten which were covered with the calcareous tubes of *Spirorbis borealis*; these must make a large contribution to the mineral requirements of the sheep.

Summary The Orkney sheep found on North Ronaldshay subsist entirely on seaweed. They are vigorous and healthy animals, and show no clinical symptoms of any nutritional deficiency. Seaweed of the order *Laminariales* forms the bulk of the diet, although a large variety of other red, green and brown weeds are eaten to a much less extent. The most palatable species are: (a) *Rhodymenia palmatta*; (b) *Chondrus crispus* and *Gigartina mamillosa*; (c) *Laminaria digitata*—particularly at the junction of the stipe and frond. The fauna associated with the seaweed are also of nutritional significance.

References

1. E. J. Sheehy, J. Brophy, J. Dillon and P. O'Muireachain. *Econ. Proc. R.D.S.* (1942), **3**, 150.
2. R. O. Pringle. *Trans. High. Agric. Soc.* (1874, 4th Series), **6**, 1.
3. R. Scarth and G. Watt. *Trans. High. Agric. Soc.* (1939, 5th Series), **51**, 1.
4. J. Hendrick. *Agriculture* (1916), **22**, 1095.
5. C. E. Hercus. Cawthorn Lecture (1929), Nelson.
6. L. B. Moore. *Dept. Sci. Ind. Res. N.Z., Bull.* 85 (1941).
7. B. J. Senior, P. Collins and M. Kelly. *Econ. Proc. R.D.S.* (1946), **3**, 273.
8. S. Y. Zafren. *Nutr. Abs. Rev.* (1937), **7**, 1, 1158.
9. J. Ringen. *Nutr. Abs. Rev.* (1939), **9**, 3, 3787.
10. D. E. Tribe and E. M. Tribe. *Scottish Agriculture* (September, 1949).
11. D. P. Wilson. *Life of the Shore and Shallow Sea* (1935).

RUSHES IN GRASSLAND

Professor H. Ian Moore, M.Sc. Ph.D.
Seale-Hayne Agricultural College, Newton Abbot, Devon

THE presence of rushes in grassland is generally regarded as indicating a faulty or non-existent drainage causing waterlogged conditions. Broadly speaking, this is true; but of recent years the march of the plough into fields that for many generations have been undisturbed by man has shown conclusively that the common rush is a plant which is equally at home on well-drained land, light soils and heavy soils, always provided it is allowed to reign supreme and not subjected to competition. From many points of view it is unfortunate that rushes have been so widely acknowledged as indicators of wet land, for there is little doubt that this has given the impression in many cases that drainage was the first and essential step towards eradication. Because drainage is an expensive operation, little, if any, action has been taken to deal with the invaders, whereas with appropriate cultural treatment they might have been eradicated completely.

Within recent years the question of rush infestation has assumed disturbing proportions. Vast acreages of poor, worn-out grassland were ploughed out for cropping or direct reseeding during the years 1939-45, and a considerable proportion of this having been laid back to grass now carries a rush-dominant sward. Of such magnitude is the problem that a field-to-field survey carried out by the West Riding W.A.E.C. in 1946 ([1]) showed that in this county alone 10,000 acres of land were badly infested; and of these at least 1,500 acres contained more than 60 per cent of rushes. In other counties the same sort of figures could be obtained. Yet with suitable treatment this grassland could be freed of the intruder in two or three seasons by normal methods of cultivation.

The problem is not new; following the 1914-18 war, farmers in the high rainfall regions of the west experienced the same trouble. Then, however, the affected acreage of land was relatively small and the problem was often accepted as just one of the burdens of war. Today, however, because of the considerable acreage involved, complacency.

The survey referred to above provided direct evidence that in most instances only spasmodic efforts had been made to eradicate the rushes, that fertilizer treatment had been neglected or was inadequate and that cross-cropping had in many cases impoverished the fertility of the soil prior to reseeding. Repeated haying of newly reseeded fields was also a likely contributory factor.

Control by Good Husbandry Few plants surpass the common rush (*Juncus communis*) in its ability to seed and provide a legacy for the future. On an average piece of rushy land no less than 8,000,000 seeds can be produced on a square yard in one season. To add to the difficulties of eradication these seeds can remain viable for upwards of sixty years ([2]), germinating readily when brought to the surface. Contrary to the general opinion, waterlogged conditions or a high water-table are not essential for the establishment of the seedlings; the only requirement would appear to be that they must not be allowed to dry out. Fortunately, however, rush seedlings are particularly delicate; the least disturbance or mechanical injury is sufficient to kill them, whilst competition from other, more vigorous, seedlings will suppress them to the point of extinction. This is the key to the solution of the problem of rush infestation following the ploughing out of old grassland.

In districts where the common rush has grown profusely for generations, it is reasonable to assume that adjacent land not necessarily showing signs of rushes will nevertheless carry a high content of rush seed in the soil. It may be that the permanent grassland has been cleared of rushes by good management and that the arable land has always carried good crops, so keeping the rush in subjection. Under such circumstances, rushes may develop with a lowering of the standard of farming, e.g., on moist soil of poor fertility and where there is no competitive herbage. Indeed, laboratory and small-scale field trials in Yorkshire have shown this to be so. Good husbandry is the weapon to use in controlling the rush, and when this is assured rushes are not likely to present farmers with any serious problem of eradication, even though the soil teems with seed.

It is not intended to suggest that good drainage is not important ; it is, and under conditions where there is a danger of waterlogging the first step is to rectify the trouble. But from research work and observations in many parts of the country, it appears that the rush is perhaps more an indicator of soil poverty than excessive wetness. Careful attention must be given to the question of liming and fertilizing to ensure that the right conditions are secured to encourage the maximum competition to the growth of rush seedlings. Perhaps the best competition is a grass turf ; if in reseeding a close-knit turf is obtained in the shortest possible time, rush seedlings have little hope of establishing themselves. The following seeds mixture gives promise of fulfilling this requirement when sown in conjunction with adequate fertilizer dressings :

	lb. per acre
Timothy S.48	6
,, S.50	6
Crested dogstail	2
White clover S.100	3
Wild white clover	1
	18

An important point to watch is that where potential rush plants abound, the sward must be *maintained* in a vigorous healthy condition. Far too frequently the initial fertilizer treatment given at seeding time is considered adequate for many years afterwards. Failure to follow up with regular applications of phosphate and potash, ample nitrogen and lime if needed, has in very many cases resulted in a starved, thin sward facilitating the establishment and vigour of rush seedlings. In the West Riding investigation it was evident that this factor accounted in the majority of the cases for the dominance of the rush.

What of the established rushes, those which have been present for so many years that they are now regarded as inevitable ? Can they be eradicated? The work of Mercer ([3]) and others has indicated that when repeated cutting is allied to sound fertilizing the rushes can be eliminated. The treatment must be continued for a number of years and a close well-grazed sward encouraged. Quite often, cutting three times in one season is justified, and the closer the cut the greater the damage to the rush plants. Cattle will graze on young rush growth, and heavy stocking after mowing is advantageous. Compared with ploughing and reseeding, this method gives comparatively slow control of the rushes, but it has the merit of simplicity and it is cheaper. In hill country many farmers who tackled this problem after ploughing out for the 1914-18 food production campaign have asserted that ten years elapsed before the rushes were finally conquered, but today, with a clearer appreciation of the underlying principles of control, they should be eradicated much quicker.

Rushes may be killed by chemicals, and under certain circumstances this method of control may appeal to farmers. The application of sodium chlorate at 2 cwt. per acre in October will kill all the herbage, and the land can be left bare until the following spring, by which time the toxic effect of the chlorate will be dissipated and orthodox renovation methods can be brought into operation. Alternatively, should this treatment be considered too drastic, MCPA (10 per cent) at 2 gallons per acre kills the rushes without harming the grass, although the clovers may be checked severely. Here again, however, there is no short cut to success, and chemical treatment of the rushes must be supplemented by good grass husbandry to ensure that the rushes are not allowed a further opportunity of gaining supremacy.

To sum up, recent research indicates that the control of rushes in grassland is primarily a husbandry problem, and that when the right soil conditions are allied to the right grazing management to promote the right kind of sward, rushes have little chance of survival. Even long-established rushes can be eliminated, given patience and the will to tackle the job.

References

1. MOORE, H. I. and BURR, S. The Control of Rushes on Newly Reseeded Land in Yorkshire. *Journ. Brit. Grass Soc.* (December, 1948), **3**, 283-90.
2. CHIPPENDALE, H.G. and MILTON, W.E.J. *J. Ecol.* (1934), **22**, 508-31.
3. MERCER, S. P. *Agric. Progr.* (1932), **16**, 146.

AGRICULTURAL INDEX NUMBER

MONTHLY INDEX NUMBERS OF PRICES OF AGRICULTURAL PRODUCTS INCLUDING GOVERNMENT GRANTS. (BASE 1927–29 = 100)

Month	Uncorrected for Seasonal Variation					*Corrected for Seasonal Variation*				
	1939	1946	1947	1948	1949	*1939*	*1946*	*1947*	*1948*	*1949*
January ..	96	199	217	242	245†	89	179	193	215	218†
February	94	201	211	240	243†	88	182	190	217	219†
March ..	90	192	201	232	237†	91	183	191	220	225†
April ..	90	176	186	214	227†	95	182	192	222	237†
May ...	82	162	171	198	208†	91	181	192	223	235†
June ..	80	161	170	198	207†	89	181	193	225	236†
July ..	85	168	181	199†	209†	93	182	197	217†	232†
August ..	87	176	192	211†	224†	91	191	209	228†	244†
September	93	177	206	210†	223†	93	188	223	227†	242†
October ..	97	192	222	225†		92	187	216	220†	
November	107	209	235	239†		98	192	217	222†	
December	114	214	241	245†		104	192	217	221†	

† Provisional.

CONTINUOUS CLOCHES ON COMMERCIAL HOLDINGS

C. P. Quarrell, B.Sc., N.D.H.
Godalming, Surrey

THE modern continuous cloche was invented in 1912 but, except amongst strawberry growers in Hampshire, its use was for many years confined largely to private gardens. It was not until the beginning of World War II that market growers began to use continuous cloches on an extensive scale. Their interest was aroused principally because of the suddenly increased demand for home-produced salads and other out-of-season produce, owing to the reduction of imports and to the increasing difficulty of obtaining other glass equipment, such as frames and glasshouses. Once both growers and manufacturers turned their attention seriously to the use of cloches under market-garden conditions, cloche cultivation quickly became a sound economic proposition, by reason of attention to such matters as planning, use of machinery and the careful choice and timing of crops.

There is no doubt that cloches have contributed greatly to the food production of the nation during and since the war, and it has been estimated that well over five million are used by amateur and commercial growers at the present time. Now that certain materials are becoming more plentiful and some controls are being taken off, growers contemplating an increase in their glass equipment have a greater choice than hitherto, for, not only are a certain number of glasshouses being built under permit, but Dutch lights made with timber or metal frames, as well as numerous patent frame and so-called cloche structures with metal frameworks, are available in quantity. Nevertheless, continuous cloches are likely to retain their popularity, and since the technique of using cloches differs considerably from that adopted for ordinary frames and glasshouses they cannot strictly be regarded as substitutes for each other.

Features of Continuous Cloches Several different manufactured patterns of continuous cloches are available, but in recent years there has been a tendency for many structures described as cloches to be so wide and tall that they no longer conform to the original type of continuous cloche. The cultural technique and management devised and developed for continuous cloches during the war years was based on certain specific characteristics of such equipment, not shared by many other forms of glass protection for crops. I consider that a typical continuous cloche should have the following characteristics:

1. It should be reasonably rigid, and capable of being carried from place to place as a complete unit without dismantling and reconstruction.
2. A certain amount of ventilation should be permanent and, if possible, provision should be made for increased adjustable ventilation.
3. While providing protection for the growing crops there should, nevertheless, be the minimum obstruction to daylight, both from the roof and sides.
4. It should be sufficiently narrow to permit established plants to derive some benefit from natural rainfall or water applied artificially falling on and around the cloche.

It should be made clear that this is merely an attempt to define a typical continuous cloche and that it is not implied that the above characteristics prove cloches to be superior to frames or other structures. Horticulturists will realize that any structure which conforms to this description will provide a special set of environmental conditions for the crops grown under its protection—conditions which may be expected to differ widely from those obtained in glasshouses and under many types of frames. Structures made with metal frames and glass walls and roofs, but which

are so large that they are not conveniently portable and are too wide for the crops to gain any advantage from outside watering or rainfall, cannot be operated conveniently by the same technique as that used for typical continuous cloches. On the other hand, they are likely to prove more efficient for plant growth than a typical garden-frame with opaque sides or walls and are preferable to cloches for many crops, particularly because of their height. They might almost be called "all-glass portable frames".

The Cloche Holding The choice of a suitable site for the commercial continuous cloche holding is of primary importance. The difficulties to be faced when trying to grow profitable crops on an unfavourably situated holding may be almost insurmountable. Thus if the field lies in a bad frost pocket, or in a very "late" district which by reason of its situation or high altitude has a low average temperature throughout the year, there is little that even the best grower can do to improve matters. It must be remembered that although cloches provide glass protection to the crops, the temperature inside the cloches is influenced by the temperature outside, and, moreover, that many of the crops complete a large part of their life in the open air.

For early work, a district where the annual sunshine figures are high and the climate reasonably mild, such as on the southern coast of England, offers tremendous advantages. The value of long sunlight and daylight hours for glasshouse work has frequently been emphasized, and this is no less true for continuous cloche or frame cultivation. Nevertheless, approaching the other extreme, growers in districts where the sunshine figures are low and rainfall heavy can still use these glass structures advantageously for producing crops which otherwise would almost certainly fail in the open. In some of the cooler districts of England and Scotland cloches are used for growing tomatoes and for starting sweet corn and runner beans.

In any district, a site which is exposed to strong gales or wind-borne sea spray should be avoided. Similarly one with a southern aspect and a slight slope to the south is generally favourable to early production.

A suitable soil is also of considerable importance, although in most cases much improvement can be made by draining, manuring, and liming. Rapid growth and early out-of-season production is the aim of most cloche growers, hence the preference for the lighter sandy loams, which are workable almost all the year round and are well suited to early intensive production.

In common with all other forms of intensive horticulture, manuring, especially with bulky organics, such as farmyard manure and compost, must be very generous. The use of large quantities of other organic manures and fertilizers is also recommended, because cropping is expected to be intensive and heavy, and growth speedy; indeed it is hardly possible for the average grower to apply too much bulky organic material to his land these days. Chemical soil analyses are particularly valuable for ascertaining the lime requirement of the soil and for indicating any marked deficiency of any particular plant food.

Labour Crops grown with the aid of glass protection need more labour than those grown out of doors. There must be sufficient labour to control weeds, for under such intensive conditions they grow rapidly and vigorously.

Adequate labour must also be available for sowing and planting the crops, for pest and disease control, and, above all, for harvesting and marketing to be carried out properly and at the correct times. All the

workers should be interested in their job and, of course, the key men skilled in their craft. Workers moving amongst cloches need to be rather more careful in their movements than where there is no glass.

Where the cloche unit forms only a section of a large market garden, all or most of the work amongst the cloches should be carried out by a separate staff. It may be necessary to bring in outside labour at the peak of tomato picking, but those who work regularly amongst the cloches have no difficulty in avoiding damage to the equipment or themselves.

The movement of cloches from one crop to another becomes quite a simple operation with practice, and workers may be trained to work in pairs for speedy and efficient operation. In general, a cloche unit should be run with a small number of regular workers, who thus become proficient and confident in their work, rather than by bringing in large gangs of inexperienced labour to do a big job quickly at comparatively long intervals.

It is my considered opinion that every cloche grower should endeavour to install some form of irrigation for his crops. Even in the wettest years there is sure to be some occasion when such an installation will enable him to maintain production at a high level. Not only is watering valuable to enable plants to grow during a dry period, but also to make it possible for sowings and plantings to be carried out at the correct time despite drought.

The most widely used system of irrigation is that of overhead spray lines; this lends itself particularly well to cloche cultivation because relatively narrow strips of ground can be watered fairly uniformly. In recent years irrigation by means of rotating jets or rainers watering a circular area has increased in popularity for certain purposes, but, because cloches are normally set out in straight rows and alternate crops are grown on the strip system, it is not convenient to apply the water in this way. Nevertheless, in spite of their shortcomings for cloche work, circular sprayers are certainly much better than no irrigation apparatus at all.

Another form of irrigation which has been introduced comparatively recently is known as automatic trickle irrigation, but I have not had an opportunity of seeing such apparatus in action on cloche crops.

Overhead irrigation normally consists of portable spray lides supported on tripods or stands which can readily be moved to each part of the cloche garden as required. If sufficient capital is available there are many advantages to be gained by installing a system of permanent overhead irrigation, the spray lines being supported on posts about 8 feet above ground level. If the whole cloche garden can be equipped with permanent irrigation in this way the labour and inconvenience of moving the spray lines from place to place is avoided, but few growers are able to contemplate the heavy capital expenditure involved.

Planning the Holding Efficient management of a holding depends very largely upon the planning and lay-out of the crops and cloches. In this connection the length of the cloche rows is important, since excessively long rows increase production costs; for example, the produce is normally collected in containers which may be carried or wheeled on a truck to the end of the cloche row, there to await collection and transport to the packing-shed. If the rows are very long, much time is wasted in conveying the containers to the end of the cloche rows and returning to the picking point.

Another factor in connection with the length of the rows is that of irrigation. If the rows are too long the pressure of water may drop, and if an oscillator is used it may be subjected to great strain or fail to operate. On the other hand, very short rows necessitate moving the pipes on to a

new strip too frequently. As a rough guide it is suggested that the length of the cloche rows should not be more than 100 yards, while on many holdings a length of 50 yards (or even 25) will be found much more convenient. The roadway or headland should be wide enough to permit the passage of a lorry.

Incidentally, in calculating the gross returns from any particular cloche crop it is usual to use a 100-yard run as a basic unit. Such calculations are facilitated if the rows are of standard lengths in units of say, 20, 25, 50 or 100 yards.

The fact that continuous cloches have not only glass roofs but glass sides as well enables light to penetrate readily from above and from the sides on to the plants growing beneath. Nevertheless, the question whether the rows should run north to south or east to west is of some importance, at any rate in some seasons. In the spring of 1949 I noticed a variation in the growth of the lettuce crop produced in adjacent rows of cloches. The rows stretched from east to west and were set out in pairs. The row flanking the southern aspect produced earlier and better heads of lettuces than its neighbour which faced north. This was believed to be due to the effects of sunshine on the southern row, but it must be pointed out that the row facing north would give some protection to its neighbour while itself bearing the brunt of any cold winds coming from that direction.

The summer crops grown in the same cloche garden did not show a similar variation. Until more scientific information is available it is suggested that where a choice is available the rows should run from north to south, as this seems to give satisfactory results throughout the year.

When planning a new cloche section or holding it is necessary to lay out adequate roads, and they should be constructed properly so that they can be used in all weathers. The main water-pipes for irrigation will normally run alongside such roads.

A packing-shed with facilities for washing is essential. Much time and expense will be saved if the site for the packing-shed is chosen carefully and detailed attention given to the planning of the shed itself.

Cultivation Equipment This is an age of mechanization, and most growers using large numbers of cloches find it essential to have some type of mechanical cultivator or tractor. As a rule space limitations make it impossible to use full-sized, four-wheeled tractors, except sometimes after most of the crops have been gathered, when it is often possible to plough comparatively wide strips of land between stacked cloches.

For general cultivation and soil preparation throughout the season, the smaller "walking" tractors are commonly used. Those capable of ploughing are popular and, in general, a one-way plough is the most suitable. Even these, however, have the disadvantage that an open furrow is left at the end of each strip of ploughed land, and for this reason many growers prefer to use one of the rotary cultivators or rotary hoes. On the whole it seems that the combination of mechanical rotary hoeing for the general regular work amongst the cloches, and a modern four-wheeled tractor system with hydraulically operated implements for ploughing as much of the land as possible during the winter, is the best. Alternatively, it may be considered worth while to remove all cloches from the site to the headland every third autumn so that the whole of the land, including the pathways, can be ploughed and cultivated with a large tractor.

Spraying apparatus will be needed on almost every cloche holding. The importance of taking prompt measures to control pests and diseases

is, perhaps, even greater under intensive cultivation involving cloches than it is for open-air market gardening.

Strip Cropping It is probably true to say that the introduction of so-called strip cropping systems secured the acceptance of cloches by growers as practical commercial equipment. The whole principle of strip cropping depends on the movement of one row of cloches sideways to an adjacent strip of land of equivalent area which has either been left vacant for the purpose or has just been cleared of a crop. Normally the cloches are laid out in double rows, but for certain cropping schemes a single row is preferred.

Most cloche growers aim at using the glass to protect as many crops as possible during the year and try to avoid having the cloches idle for any appreciable length of time. The cloches are first used on one strip to cover the first crop of the season, usually during the period from October or January until mid-April. They are then moved to an adjoining strip and remain there protecting the second crop of the season, normally until some time in June. The cloches are then moved either on to a third strip kept vacant for the purpose or back to the first strip if by that time the early spring crop on that strip has been cleared. A typical commercial rotation of crops under cloches is as follows:

From October to April—lettuces;

April to the end of May or early June—tomatoes (plants having been raised in heat);

From June to September—cucumbers or melons.

Flowers also may be grown successfully under cloches. Limitation of space prevents full discussion in this article of the various crops which can be included in these rotations, but much information on the subject is already available. It will be realized that when crops such as sweet peas are raised under cloches, or any other early crop which has to remain *in situ* for most of the remainder of the year, it will not be practicable for the cloches to return to that position to protect the third crop of the season. In such cases it is obvious that a third strip must be provided if the cloches are to be used to protect the third crop. Some growers believe that there is an advantage in having a third strip available, even when such provision is not absolutely essential. It is argued that this avoids hurried preparation of the land on strip number one in between the first and third crops and that correct timing is, therefore, more easily secured. Moreover, when strip number one is eventually freed of its crop it can be used to produce an open-air crop, taking care to choose one that will benefit by the use of irrigation, which is almost certain to be part of the cloche-garden equipment.

The past two seasons, 1948 and 1949, have not been particularly favourable for some of the third cloche crops of the year. Thus in 1948 melons produced poor yields in many districts, owing to the lack of sunlight, whereas during 1949 the many large, fine melons produced by an almost record year of sunshine had to meet severe competition from abroad. Possibly next season a balance will be struck between the two. It is never wise to condemn any market-garden crop because of its failure for one cause or another during a single year or two. It may be, however, that some growers will consider stacking the cloches after the second crop of the season and using the remaining land for outdoor cropping, since production costs are bound to be a little higher while glass is being used.

The principal kinds of flowers grown with the aid of cloches are autumn-sown annuals (especially sweet peas and calendula), spring bulbs and corms, and perennial flowers for cutting. A few growers use cloches instead

of frames for accommodating boxes of bedding plants. Intensive vegetable growers can put them to valuable use for raising seedling lettuces, cauliflowers, cabbages and other plants for planting in the open early in the year. Where the outside land is available the use of cloches for raising vegetable plants may prove more profitable than for growing crops such as lettuce to maturity.

Good Marketing A brief word on marketing is necessary, since however well a crop is produced, the importance of its final presentation to the public cannot be over-emphasized. Much of the produce grown with the aid of cloches is similar to that imported from the Netherlands and other foreign countries, and consequently the home produce has to compete with very well packed and graded fruit, vegetables and salads. Generally speaking, the cloche grower, since he operates a comparatively modern section of the industry, is already fully alive to the necessity of careful and honest grading and attractive packaging. When supplies of containers and packing material become more readily available, no doubt the intensive grower will improve his packing technique still further. Every effort should be made not merely to send only properly washed and correctly graded produce to market but also to ensure that the consumer receives it in as fresh a condition as possible. It is in respect of freshness that the British grower may have an advantage over imported produce, and this advantage should be exploited to the full.

References

CHASE, J. L. H. Cloche Gardening. Faber.

SHEWELL-COOPER, W. E. Continuous Cloche Gardening. English Universities Press.

WYSE-GARDNER, C. Cloche Cropping Rotations. Intensive Gardening Press.

QUARRELL, C. P. Continuous Cloche Gardening. *R.H.S. Jour.* (March, 1947).

QUARRELL, C. P. Intensive Salad Production (4th Edition). Crosby Lockwood.

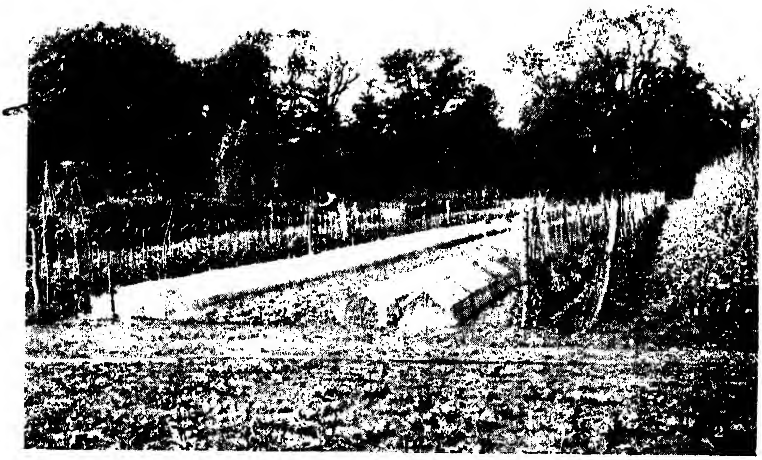
---

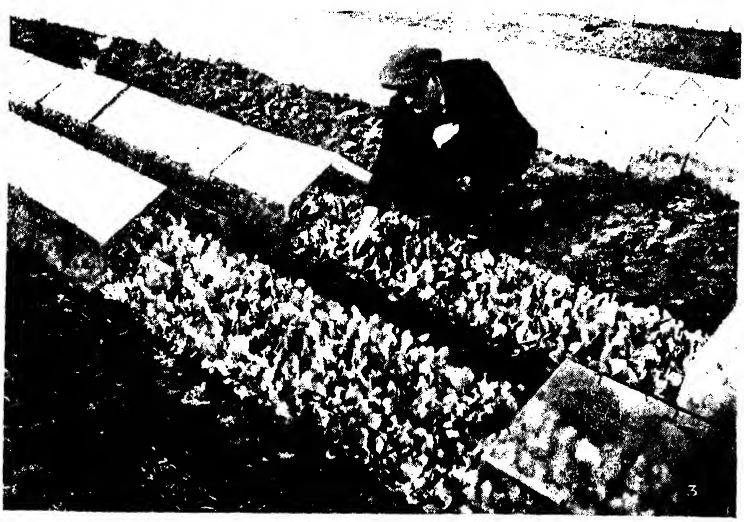
1. **Two-strip rotation.** Shows the system of moving cloches from one crop to another. Note that the workers are operating in pairs.

2. **Three-strip rotation.** On extreme right are calendulas and sweet peas. These were protected by cloches from October to April. The cloches were then moved inwards to protect tomatoes, where they remained until the latter part of May. The glass was then moved to the position shown in the photograph to protect melon or cucumber plants. The same sequence was followed by the second two rows of cloches moving from the left towards the right. In between the two double rows of cloches the wide central pathway is shown cropped with an open air crop of radishes. When these are cleared the vacant pathway is wide enough to accommodate all 4 rows of cloches stacked up-ended and still permit workers to walk along either side of them to attend to the melon plants.

3. **Pricked-out lettuce seedlings** over-wintering under cloches. These seedlings will be available for planting under cold glass or in the open in early spring.


1


2


3

1. Typical marginal land before improvement—heather, gorse and coarse grass (West Throphill, Morpeth).

Photos. M. Cohen

2. Typical marginal land before improvement—coarse grass rushes, etc. (West Throphill, Morpeth).

3. Marginal land foreground after improvement : background in original condition (Eglingham Hill, Alnwick).

Photos. M. Cohen.

4. Marginal land—foreground after improvement : background in original condition (Eglingham Hill, Alnwick).

NEW SWEET CORN FROM AMERICA (See pp. 410-5)

Photo. *L. S. Clarke*

Ears of *Northern Cross* sweet corn picked at the edible stage.

MARGINAL LAND

1. NORTHERN ENGLAND

A. McVicar, B.Sc., N.D.A., N.D.D.

Director, Northern Province, National Agricultural Advisory Service

In the marginal land of England and Wales there is a great potential for the expansion of home food production. The following article is the first of a series of four, covering representative poor land in the North, Pennine, and South-West areas of England, and Wales.

THE precise definition of the term "marginal land" is by no means simple, but it may be taken as land whose productivity is relatively low by reason of inherent deficiencies in fertility, or lack of drainage, or inaccessibility, or climatic factors such as low temperatures, high rainfall, shortness of growing season, etc., or combinations of any or all of these or other limiting factors. The restoration and maintenance of productivity of such land requires expenditure substantially higher than that normally needed for good average land, and this reduces the margin of profitability. In considering the question it is important to distinguish between marginal land and marginal farming, which arises from factors other than marginality of the land itself, such as lack of capital, labour, equipment, or of farming skill.

Marginal land areas such as extensive belts of poor sand, or heavy clay, or peat, exist in many parts of the country, but in the North of England marginal land is understood generally to mean the areas which lie between hill land, on the one hand, and good quality lower-lying land on the other. It is difficult to estimate accurately the amount of marginal land in the Northern Province, but having regard to the relatively high proportion of hill and uplands in Northumberland, Durham, Cumberland and Westmorland, it is obvious that the proportion is high, and the total which is capable of improvement without unduly high expenditure probably exceeds 275,000 acres. Marginal land is widespread throughout the hilly regions, but the largest areas in Northumberland exist in parts of Glendale and the Alnwick, Morpeth, Rothbury, Bellingham, Castleward and Hexham districts; in County Durham, in the districts Chester-le-Street and Lanchester, Weardale Crook and Willington, and Darlington and Barnard Castle; in Cumberland, mainly in the Brampton and Penrith districts; and in Westmorland, the fringes of the Eden Valley, Lowther Valley, Ullswater region in the north, and the Lune Valley, the Kent Valley and the Lyth Valley in the south.

Farming in these so-called marginal areas has been traditionally concerned with livestock. In the past, rearing of store cattle and sheep has been the main feature, and although this is still true, milk production, with its financial attractions, has been steadily increasing as a result of the development of road transport; indeed on many of these farms it is now an important, if not the chief, source of income. Where milk is produced the output varies from small quantities surplus to the needs of calf rearing to output on a considerable scale. The dominant and common characteristic of marginal land is its low level of fertility, and production, whether in terms of cattle, sheep or milk, is low. The basic problem, therefore, is how best to raise and maintain fertility, and this involves some consideration of the types and characteristics of the soils occurring in the marginal land areas.

Types of Soil in Marginal Areas Broadly, there are three main types:

1. Heavy Boulder Clay. This occurs extensively and is well exemplified in Northumberland and north-east Cumberland; it is also found over much

of Westmorland, and, to a less extent, in West Durham and East Cumberland. The main feature of these soils is the extreme deficiency of phosphate, which is accentuated by the fact that much of it has lain in grass for many generations. To maintain a good sward regular dressings of basic slag, or other phosphatic fertilizers, must be applied, because of the very rapid rate of reversion (i.e., change to less available forms) which takes place. This is borne out by the results at Cockle Park, where even now after fifty years of phosphatic manuring there are signs of phosphate reversion at the end of the six-year intervals between applications.

Because of their bad soil structure, these soils are often difficult to work in the preparation of seedbeds, but where wild white clover has been established the surface soil is gradually converted into a workable loamy condition. Drainage is a problem on these soils, and pipe drains seem to have only a limited lateral effect.

All of these boulder clays are deficient in lime to a greater or less extent, depending mainly on altitude and rainfall. The most acid areas occur in Westmorland and West Northumberland, but, taken as a whole, these heavy boulder clays are not so deficient as the marginal land, on the lighter soils in the same areas. Lime alone, however, has little effect on texture and drainage and, whilst phosphate is of first importance as a factor in renewing fertility, liming is necessary to get the best response from phosphate.

2. Glacial Sands and Gravels. These are often in a hump-backed series of hills, formed as terminal moraines, or lake deposits during the retreat of the glaciers. They occur in north-west Northumberland, north-west Durham, and in the Brampton district in Cumberland. There are extensive areas of very poor grassland on these soils between Gilsland and Brampton, and south of Brampton. In their natural state these soils are very poor, and less responsive under grass than the boulder clays.

The key to the improvement of these glacial sands and gravels is lime, and in order to maintain them in a fertile condition liming at frequent intervals is necessary, on account of their porous open texture. They are also naturally deficient in humus, phosphate, potash and nitrogen. For the maintenance of a satisfactory sward, regular manurial treatment and liming must be given. Where treatment on these lines has been applied, e.g., near Wooler, and Durham City, the land has been made very productive. Horton Moor (north-east of Wooler) is an example of an area of glacial sands which awaits improvement.

3. Sandstones. There are at least three geological rock types which can be classified together as producing poor light acid soils on which there is marginal land in all four counties.

Northumberland. In this county Fell Sandstones, Cement Stones and the Scremerston Coal Group give rise to these sandstone soils. Good examples are seen due east of Wooler (Westwood Moor) and on the high rugged ridge running north and south to the west of Belford, and also round Chillingham; others occur north and south of Rothbury, in the North Tyne Valley, and south of Slaley.

Durham. Good examples of these soils occur on the Coal Measure sandstones and Millstone Grit outcropping in the Muggleswick and Tow Law districts, and also north and south of Wolsingham.

Cumberland. The most important examples are found on the unglaciated parts of the Bewcastle area, and in the Lake District.

Westmorland. Here they are found on the Silurian shales and sandstones in the Kirkby Lonsdale neighbourhood.

Whatever their geological origin, all these soils are very deficient in lime and phosphates, and they are in many respects comparable with the glacial sands. Most of the pure heather-covered areas are soils derived from the Fellstones or Millstone Grit, and are extremely acid; they are even more acid than the glacial sands on which heather is the exception, e.g., at Doddington in Northumberland, and King Harry's Common in East Cumberland.

The sandstone soils in Westmorland around Kirkby Lonsdale, and derived from the Silurian shales, are very acid, but quickly responsive to treatment. All forms of lime are effective, but it is interesting to notice that magnesian limestone has given better results than ordinary lime.

In general, the most heavily covered bracken areas occur on these sandstones.

Whilst there are marked physical differences between all these soil types, it is obvious that lime and phosphate deficiencies are common to all, and that potash shortage exists in the lighter soils, particularly the glacial sands. Any attempt at improvement must take these into account.

Methods of Improvement The direction or directions in which improvement is tackled depends upon farming policy in relation to any particular farm. There are several ways in which this may be done—by improvement of existing grassland, by suitable surface cultivations, liming and application of basic slag or other phosphatic fertilizers, by ploughing up poor grassland, liming, fertilizing and reseeding it direct, or by ploughing, liming, fertilizing, and seeding down after putting through an arable rotation, or after one or more pioneer crops. All these methods have their place, and have been tried out successfully in various parts of this Province, as in other parts of the country.

The potentialities of marginal land, and what can be achieved as a result of improvement, are perhaps best illustrated from actual experiences, of which the following are examples:

CONSHIELD, WARY-ON-TYNE (Messrs. Moralee and Ridley)

This is an interesting example of the improvement of an area of poor, unproductive pasture, situated at about 650 feet above sea level on boulder clay, and estimated to have a rental value of 4s.-5s. per acre in 1939. In that year it was decided to embark on a programme for improving 149 acres, and, as a first step 28 acres were fenced off and ploughed in June; ploughing proved to be difficult because of large stones which had to be removed. During very thorough seedbed preparations lime was applied at the rate of about 30 cwt. per acre, followed by the application of 5 cwt. basic slag and 4 cwt. compound fertilizer (containing nitrogen, phosphate and potash). The seeds mixture, which was essentially perennial ryegrass, cocksfoot and wild white clover with Italian ryegrass and 3 lb. rape and 1 lb. mustard, was sown at the end of July. Grazing started seven weeks after seeding, and 398 cross lambs were fed off the rape, the profit on these more than paying for the whole cost of the work.

In the following spring the field was stocked with 20 cattle, which subsequently was raised to 35 and ultimately to 80. These were grazed for 5 weeks, and then reduced to 55 for 3 weeks, and by the beginning of August to 16 cows with calves, and 60 Cheviot ewes. Ewes and lambs had been put on in the spring, but were removed early when it was found that they "tracked" too much.

The success of the 1939 work led to similar operations on an adjoining 34 acres in 1940. Treatment was on similar lines, but mustard omitted from the seeding. The remainder of the 149 acres has been improved by

stages, some by direct reseeding, and some after three or even four crops of sheep keep.

Some measure of the improved fertility is shown by examining the figures of stock carried. There are no figures for the individual fields in 1939, but the whole of the 149 acres before improvement was stocked with 17 Shorthorn cows with their Angus-cross calves, and 100 Cheviot ewes and their lambs. The two fields first improved—28 acres in 1939 and 34 acres in 1940—and totalling 62 acres, now carry 60 bullocks regularly each year, and these are fully three-quarters fat at the end of the season. The swards on these fields—now 9 and 10 years old respectively—consist of perennial ryegrass, cocksfoot and wild white clover, with small traces of bent here and there.

A question which is frequently asked in connection with work of this kind is: how long will the improvement last? The answer depends on a number of factors, not least manurial treatment and grazing management. These particular fields have received regular dressings of basic slag every two to four years, and very careful and skilled consideration has been given to their grazing. Except for the first year, they have not been grazed by sheep, and each year cattle are not put on until about the end of April. It is not possible to forecast how many more years the quality of the swards and the output of stock can be maintained at their present level, but after ten years the fields are still in a very satisfactory condition.

Mention should be made that adequate water was provided, and that the farmers concerned were able to put in adequate stock to eat off the flush of grass—a point of the greatest importance in the first year of reseeding.

COBRA CASTLE, EGREMONT, CUMBERLAND (Mr. T. Cook)

This farm, adjoining the open fell, lies at an altitude of about 630 feet, and has most of the disadvantages of a marginal farm. Its improvement since 1939 provides a striking example of what can be done by an enterprising farmer.

Except for about 20 acres of gravelly land, the soil consists mainly of heavy clay. The total area of the farm is 151 acres. In 1939, 101 acres were rough grazing—covered largely by gorse, blackberry bushes and rushes, and 50 acres of grass and arable in a poor and impoverished condition. At that time the stock consisted of 8 cows in milk or in-calf, 12 stirks, 9 calves and 70 ewes and their lambs. In 1949—that is, ten years later—the farm comprises 120 acres of grass and arable in a good state of fertility, and 31 acres of rough grazing, which it is hoped to convert into useful land in the near future. The stock at the 1949 June census was made up of 15 cows and heifers in milk, 2 in-calf cows, 6 in-calf heifers, 16 stirks and 1 bull, and 138 ewes and their lambs. Whereas in 1939 it was necessary to buy hay and roots to supplement the foods grown on the farm, there is now a surplus after meeting the needs of the increased numbers of livestock.

What has happened during the past ten years to bring about this remarkable change? The answer lies in the improvement of the land. Drainage was a first consideration—part being completely re-drained, and the remainder having the old drains lifted, rodded and re-laid. Dykes, fences, and gates also received attention. The whole of the farm, except the 31 remaining acres of rough grazing, has been limed at the rate of 2 tons of quicklime per acre, and treated with the equivalent of 15 cwt. per acre of basic slag. All the worst land has been reseeded direct. A start was made in 1943 under the Marginal Assistance Scheme, and by 1948, 37 acres had been dealt with in this way. The remainder, which is

capable of being cropped, has been improved under arable conditions. In 1940 the tillage acreage was 17, made up of 11½ acres oats, 3 acres potatoes, and 2½ acres green crops; the corresponding figures in 1949 were 13 acres oats, 3 acres potatoes, and 6 acres swedes and kale, a total of 22 acres. Although the tillage area has not been increased to any great extent, it is estimated that production from the 22 acres is several times as great in 1949 as that from the 17 in 1940. It is of interest to note that seed potato production is included in the farming activities.

Before the war the only source of income was the sale of cross-bred lambs and a few store cattle. Butter was made on the farm, and there was an occasional in-calf cow to sell. A change to milk production was made in 1942 (a 22-cow byre had been built by the landlord) and the average output now is between 600 and 700 gallons per month.

On the sheep side, the policy throughout has been to cross Herdwick ewes with an English Leicester ram. The size of the lambs has increased considerably, and whereas formerly they were marketed in poor store condition, they can now be sold fat or as stores, as desired, and in much improved quality.

The improvements made on this farm provide a very good illustration of the benefits that accrue from the application of knowledge and experience.

ELRINGTON HALL, HAYDON BRIDGE (Mr. G. S. Clarkson)

This is an example of a high-lying marginal farm whose fertility and production have been raised principally by the application of lime and basic slag to the existing herbage. The house and farm buildings stand 600 feet above sea level, with the land running up to 1,000 feet and bordering the open heather fells. The total acreage is 525, of which 300 acres lie above the 700 feet contour.

Since 1921 a policy of land improvement has been followed, involving the regular use of lime and basic slag by treating approximately one-third of the farm each year. This has been done on the high-lying grazings, and has effected a remarkable improvement in the composition and quality of the herbage, changing it from fescue-agrostis, nardus and rushes to agrostis-white clover mainly, with traces of perennial ryegrass, Yorkshire fog and fine-leaved fescues. All trace of heather has disappeared, though the area is surrounded by heather land. The average initial applications were 2 tons per acre of quicklime and about 15 cwt. of basic slag, and these have been repeated at reduced rates every three or four years. Similar treatment was given to the lower-lying land in the earlier years. More recently, the practice has been to give a small dressing of fertilizer each year for this land, and to lime every three or four years.

The high-lying land has been stocked with Highland × Shorthorn cows, mated with the Aberdeen-Angus bull. The cows remain out all the year round. Additional food is provided for them in the winter period, normally oat straw once per day, starting about mid-December, but in severe weather they receive additional supplies in the form of oat sheaves. Hay replaces the oat straw during February, and as calving approaches, two mangolds per cow is given as an extra. Originally this higher land carried a Blackface stock, but following the improvement was replaced by Mule ewes (Blackface × Border Leicester) many years ago. These ewes crossed with a Half-Suffolk or Hampshire Down ram produce very good lambs, the average crop being 170 per cent. The rate of stocking is one ewe to two acres. Mineralized salt licks are supplied for both the cattle and sheep.

The lower fields (i.e., below the 700 feet contour) provide grazing, hay (40–45 acres) and arable crops (20 acres oats and 15 acres of green crops, including two acres of mangolds). Part of the green crop consists of rape

and turnips sown in June for autumn grazing by sheep and lambs. Of the lower grazing, about one-half is in new leys, and it is stocked with 1½-to 2-year-old bullocks, and a flock of pure Border-Leicester sheep.

Silage is made from aftermath, pasturage, or oats cut green, and chopped for the purpose.

Some idea of the improvement effected on this farm since 1921 is obtained by comparing the stock figures then and now. In 1921 the farm carried 49 cattle of all ages, and about 390 head of sheep and lambs: the corresponding figures in June, 1949, were 232 cattle of all ages and 474 sheep of all ages.

It is interesting to note that Mr. Clarkson feels that supplementary mineral feeding for both cattle and sheep is worth while from the point of view of general health and well-being. A considerable volume of evidence is accumulating that major and trace mineral deficiencies in sheep and cattle are widespread—much more so than is generally recognized, and investigations on this point by the N.A.A.S. and the Veterinary Advisory Service are in progress in the Province.

These examples of what has been done by enterprising and progressive farmers are evidence that marginal land tackled in a pioneering spirit is capable of substantially greater production. In these brief accounts no reference has been made to costs, but in each case the farmer concerned is satisfied that the expenditure incurred has well justified itself. With the knowledge available, and given a widespread attack on marginal land, a significant and positive contribution can be made in livestock expansion. Assistance under the Ministry's Marginal Production Scheme provides a valuable incentive to this end. The large area formerly under cultivation a century or so ago, as judged by the old rigs and furrows, seems to be the most promising on which to operate, and its improvement in fertility and production would push the marginal boundary further up the hills.

Thanks are due to Professor H. C. Pawson, King's College, Newcastle-upon-Tyne, for helpful suggestions, to my colleagues Messrs. A. Blenkinsop, S. Campbell, H. C. Davidson, and H. Mead for certain data, to Dr. M. Cohen for the photographs, and to the farmers mentioned for permission to record and publish their results.

SCIENCE IN THE MUSHROOM INDUSTRY

R. L. EDWARDS

Mushroom Research Station, Yaxley, Peterborough

SEVERAL strains of mushrooms similar to the common field mushroom have been cultivated on a commercial scale for over two hundred years, and scientists have taken an interest in some of the problems of the industry during much of that period. Mushroom-growing is still mainly a traditional craft: although scientific investigation has supplied a background of precise knowledge and introduced some improvements, the basic operations remain the same as they were a century ago. Horse manure is still the usual medium, and the process of composting it is essentially the same.

The first practical application of scientific methods was the development of spawn from germinated spores about 1895. The wild spawn previously used was derived from growing mycelium, and was subject to variation in quality and to contamination with parasitic and competitive fungi and with insects. Pure culture spawn was first grown about 1905 on

a sterile medium inoculated with pure cultures derived from single spores or aseptically from mushroom tissue. All the operations involved in spawn-making could be carried out with full aseptic precautions, and it became possible to maintain pure cultures for trial, selecting for use those which were most reliable and productive.

The production of pure culture spawn, using composted horse manure, has been described by W. M. Ware and H. H. Glassscock (1947), and that of grain spawn by C. Terrier (1946). Grain spawn, using wheat or rye, is widely used in the U.S.A. and is particularly suitable for highly mechanized units where spawn is scattered mechanically on trays of prepared compost. It must be used fresh, and it encourages rats and mice which dig it out of the beds. Tobacco spawn is also used in the U.S.A. The wide, hollow tobacco stems hold water and at the same time allow passage of enough air for vigorous mycelial growth. The trace of residual nicotine repels insects, and tobacco spawn does not deteriorate rapidly in storage.

Mushroom Nutrition Styer (1928, 1930) showed by pure culture experiments that mushroom mycelium can use as sources of carbon glucose, maltose, xylose, cellulose, xylan, casein, albumin, pectin, and a wide range of plant residues. Growth was most vigorous on materials containing lignin. He found that ammonium salts, urea, glycine, asparagine, peptone, and proteins were adequate sources of nitrogen. Similar results have been obtained by others, and there is no difficulty in growing mushroom mycelium in pure culture on the usual sterile media. Unfortunately the mushroom does not fruit on such media; indeed, fructification has been obtained only on materials containing humus, usually fermented fibrous vegetable matter. This excludes anything resembling the simplicity of pure culture methods in nutritional work on the mushroom as a crop, and less direct methods have been employed.

There is analytical evidence (e.g., Hebert and Heim (1911), Waksman and Mc Grath (1931), Waksman and Nissen (1932) to show that the mushroom takes up considerable amounts of cellulose, hemicellulose, lignin and protein from horse manure composts. The use of this analytical approach is restricted to major nutrients, owing to the presence in spent compost of much mushroom mycelium, which is necessarily included in the final analysis; for example, the mushroom must have taken up from the compost some of the protein which is recorded as still forming part of the spent compost. In fact, this type of analytical balance has only been used qualitatively to demonstrate that cellulose and lignin are major sources of carbon, and that protein is the main source of nitrogen. It has not been applied to phosphorus, potash or any of the minor nutrients.

The most recent report on mushroom nutrition, and one of the most comprehensive on the mycelial phase, is that of Treschow (1944). He confirmed that pentoses, hexoses, disaccharides, some organic acids, and pectin were good sources of carbon. Starch, inulin, tartrate, and malate were less satisfactory. He found that ammonium salts and several amino-acids were equally good as sources of nitrogen, but nitrate was inferior.

In the first detailed quantitative study of mineral requirements, Treschow found that a balance must be maintained between calcium, magnesium, and potassium. The best growth was obtained when all three were between 0.0025M and 0.0075M (in a liquid medium). He found that calcium was particularly necessary, and suggested that the function of gypsum in Pizer's (1937) experiments might have been to adjust the calcium potassium-magnesium balance. The occurrence of calcium oxalate crystals on mushroom mycelium is well known, and a considerable amount of

calcium must be deposited in this form. It is not known whether this is a necessary detoxication or merely incidental, due to the excretion of oxalate in presence of dissolved calcium. Phosphorus was also found necessary by both Styer (1928) and Treschow.

Stoller (1941) recommended the use of a mixture providing eight trace elements, based on the analysis of mushroom ash, in synthetic composts. Treschow found iron necessary for mycelial growth, but the addition of copper, manganese, and zinc had no effect.

To summarize, studies of mycelial growth have shown that the mushroom can use a wide range of sources of carbon and nitrogen and also needs calcium, magnesium, phosphate, potassium and iron. Analysis of horse manure composts has shown that in practice the chief sources of carbon and nitrogen are cellulose, lignin and protein. The presence of sodium, aluminium, sulphur, silicon, chlorine, manganese, chromium, zinc, boron, bromine, and iodine in mushrooms is presumptive evidence but not proof that they are needed.

Synthetic Composts The prospective decline in the use of horses and in the supply of horse manure stimulated a search for possible alternatives, and work on this subject has been in progress, mainly in the U.S.A. and France, for twenty years. Existing knowledge suggested that a suitable compost might be made from straw by replacing the nitrogenous and mineral constituents of horse droppings. Demolon (1935), Sinden (1938) and Lambert (1941) described composts developed on these lines. Urea was popular as a source of nitrogen because it left no inorganic residue. Demolon also added a small quantity of nitrate. Sinden added wheat grain as a source of readily available carbohydrate to promote fermentation and heating in the stack. Lambert added dried blood with the urea, and soil to prevent leaching and loss of nitrogen.

Single arbitrary formulae of this type were criticized by Stoller (1941, 1943), who laid down proportions of nitrogen, phosphorus and potassium which he claimed could be added in any form to lignin-containing material to form a satisfactory mushroom compost. He also recommended the use of a mixture of mineral salts to supply the trace elements, familiar to workers on plant nutrition. It is unfortunate that more details are not given of the "extensive experimentation" referred to in Stoller's (1943) paper which led to his ratio 13 lb. N, 4 lb. P_2O_5, and 10 lb. K_2O per ton of the fibrous material containing 70 per cent moisture. Nor do the widely scattered yields with different sources of nitrogen inspire confidence in the proposition that this ratio is the only, or even the most important, characteristic of a satisfactory compost.

Stoller (1941) also described an entirely new approach to mushroom cultivation in the use of a process which he called "coprination". The published descriptions (Stoller, 1941, 1943) leave the details of this process a little obscure, but it seems to depend on a reaction rather similar to the tanning of leather, nitrogeneous substances combining with a coprinating agent such as the lignin in spent liquorice root, to form products which are available to the mushroom but not to most of those other microorganisms which, if they could flourish, would outgrow the mushroom and eliminate it from the bed. One of the objects of composting horse manure is said to be to convert the carbon and nitrogen present into forms which are readily available to the mushroom and much less so to any commonly occurring mould which might compete with it. There have been occasional references to Stoller's coprinating process in trade periodicals but there is no indication of its extensive use by commercial growers.

Stoller's formula has formed the basis for a number of experiments on orthodox lines by individual growers in Great Britain. The general opinion seems to be that these synthetic composts give an excellent spawn growth and one or two good flushes of mushrooms, but they lack stamina and the crop fades out at a lower total yield than that usually obtained with horse manure. Assessment of these very scattered observations is made more difficult by the wide range of yields "normally" obtained; so much so that a critical-minded statistician who saw the yield figures on most commercial farms would dismiss as insignificant any single difference less than 50 per cent below or 100 per cent above the annual average yield.

Sinden (1946) describes in detail the preparation of a synthetic compost which gave yields equal to those obtained with horse manure. The nitrogen content is not directly comparable with that recommended by Stoller, but Sinden and Stoller both found the potassium requirement to be 30 lb. K_2O per ton of dry matter. Sinden's compost was based on a mixture of wheat straw and maize fodder. Practically all American synthetic composts contain other organic materials, such as wheat and brewers' grains, and they cannot be used in Great Britain in their original form. According to Sinden (1949), synthetic composts are not popular in the U.S.A., where growers and research workers have recently concentrated more on methods of economizing in horse manure than on replacing it. They are developing rapid methods of composting to reduce losses, and using shallow beds which give better yields per ton of manure.

There are several proprietary mixtures on the British market, most of them intended for use with straw, and their claims range from a conservative "1 lb. per sq. foot can be obtained" to the quotation of individual cases where crops of 3 lb. per sq. foot have been grown. To put these claims in their proper perspective they must be compared with the equally wide range of yields from crops grown on horse manure; authentic yields of 4 lb. per sq. foot have been obtained, and 3 lb. is regarded as a good average crop on some farms, while others average no more than 1 lb. per sq. foot. The comparison of yield data is complicated by the fact that a mushroom crop has no sharply defined end. Some growers operate on a fairly tight schedule, emptying their houses after picking for three months or less; they find that the diminishing rate of production makes further picking uneconomic, although their composts would often produce another ½ lb. per sq. foot or even more if they were kept going to the point of exhaustion. Other growers pick for periods up to six months, emptying their houses only when production has completely ceased. These wide variations emphasize the need for properly designed experiments to assess the value of any artificial compost.

A systematic investigation of the mushroom's NPK requirement in wheat straw composts has led to a formula (Edwards, 1949) which is believed to give yields comparable with those obtained from heavy stable manure. Only materials available in Great Britain are used.

Diseases and Competitors Conditions in a mushroom house are naturally ideal for the growth of many other fungi, and the mushroom forms a ready host for several of them. Mycologists have identified three common parasitic fungus diseases. *Verticillium malthousei* (Ware, 1933) and *V. psalliotae* (Treschow, 1941) cause disease characterized by brown marks on the cap, turning grey. If attacked when small, the stalk may split and peel, and the whole mushroom may be deformed. *Mycogone perniciosa* causes soft rotting, with severe deformity of the mushroom. *Dactylium dendroides* (cobweb

disease) grows over the mushroom, as the very descriptive popular name suggests. The occurrence, prevention, and treatment of these diseases are described in most books on mushroom-growing, and they have been summarized by Atkins (1945, 1948). *Cephalosporium lamellicola* sometimes attacks mushrooms, causing "gill mildew" or "flock", but this is comparatively rare.

There are also diseases attributed to the presence of specific bacteria, but the relation between organism and disease is less clearly defined. Bacterial disease appears when humidity is excessive and is usually controlled by improving air conditions.

The distinction between fungi parasitic on the mushroom mycelium (e.g., *Myceliophthora lutea*, Mann, 1947) and non-parasitic competitors in the bed (e.g., white and brown plaster moulds) may be real and important, but it is extremely difficult to apply in some cases.

Several mushroom bed invaders are well known and methods of prevention have been found. "Pasteurization" at 140° F. in the beds kills the spores of *Scopulariopsis fimicola* (white plaster mould) and *Papulaspora byssina* (brown plaster mould) and also those of the parasitic fungi already mentioned.

The responsibility of *Fusarium* sp. for a "damping off" disease of mushrooms, described by Wood (1937, 1939), was questioned by Kligman and Penney (1943) who failed to repeat Wood's experiments. No one appears to have studied this disease more recently.

More information is also needed about *Myceliophthora lutea* (*Vert de Gris* of Costantin and Matruchot (1894), Matt disease of Manns (1947)), and *M. sulphurea* which, according to Sinden (1948), does similar damage in mushroom beds, but forms small colonies instead of a widespread mat of mycelium.

The growth of *Cephalosporium costantinii*, *Geotrichum* sp., and *Trichoderma viride* on mushroom beds is said to injure the crop. Insufficient is known about these fungi to say with certainty under what conditions they cause damage or how they can be controlled.

Pseudobalsamia microspora (truffle) is much better known and is dangerous because of the resistant nature of its spores. They have been shown by Lambert (1932) to survive five hours at 180° F. and to withstand treatment with formalin and phenolic fungicides at the usual strengths. Stoller (1943) found that ammonia evolved at a high temperature in nitrogen-rich composts killed truffle spores, but this observation has not been repeated. Sinden (1948) suggested that truffle becomes established on the composting ground, even on concrete, and thence invades the compost. It may be partly controlled by spraying the ground with strong formalin, to prevent growth of the mycelium, before making or turning a stack. He did not consider that carry-over in the growing-house was a serious cause of infection.

The symptoms of a "Mummy disease" were described by Tucker and Routien (1942). They found that it spread very rapidly over mushroom beds, but they failed to isolate any causal organism and suggested that it might be due to a virus. Various "weed" fungi have been reported, e.g., *Peziza vesiculosa*, *Clitopilus cretatus*, *Clitocybe dealbata*, *Coprinus* sp., *Panaeolus* sp., but they do not appear to cause widespread damage. Many growers regard the presence of ink-caps (*Coprinus*) as promising a good crop of mushrooms.

Taking a general view of mushroom diseases, the most urgent call is for further study of bacterial disease and of those fungi which invade the compost and soil. The grower can improve his position by attention to farm hygiene and making full use of existing knowledge.

Pests The mushroom house is a highly favourable breeding place for insects and allied pests, which multiply rapidly if preventive measures are not taken.

Austin and Jary (1933, 1934) have described the species commonly found and the damage they cause It is generally agreed that Sciarid and Phorid fly larvae are economically the most serious pests, and if unchecked they can do enormous harm by eating the mycelium and burrowing into the mushroom stalks and caps. Cecid larvae were also found to burrow into mushrooms, particularly on the stalk. They commonly multiply paedogenetically, and may pass unnoticed by growers in the absence of the adult fly.

Many different kinds of mites are found in mushroom beds, and some of them undoubtedly cause damage. The mites identified as causing most damage in mushroom beds are *Tyroglyphus mycophagus*, *T. dimidiatus* (*longior*), and *Linopodes antennaepes*. Other *Tyroglyphus* sp., *Caloglyphus* sp., and *Eberhardia* sp. have also been found. In America *Tarsonemus* sp., *Pigmaeophorus americanus*, and *Histiostoma gracilipes* sometimes cause damage. It seems unlikely that insecticides used on mushroom beds will have any selective action between these and the predatory gamasid mites or the harmless *Histiostoma rostroserratum*. From the grower's point of view the only good mite is a dead one ; even when they do no direct harm, they help to spread disease spores. Springtails are sometimes found in large numbers, and they can do considerable damage, but apart from the identification of a few species little attention has been paid to them. Peak heating to at least 120° F., combined with fumigation, eliminates all these pests and gives the mushroom bed a clean start.

A recent investigation by Lambert, Steiner, and Drechsler (1949) has shown that eelworms (*Ditylenchus* sp.) are responsible for damage in the form of a soggy compost, formerly known in the U.S.A. as Cephalothecium disease. The fungus associated with this condition has now been identified as *Arthrobotrys superba*, which is predaceous on the eelworm. *Arthrobotrys* sp. has also been observed in association with eelworms in mushroom compost in Great Britain (La Touche, 1948), but no relation to damage in the bed was established.

Flies can be controlled later with the old-established pyrethrum and nicotine insecticides, but no reliable method of treating a serious infestation of mites or springtails has been found. Great hopes are entertained that some of the new insecticides will solve these problems. DDT and benzene hexachloride certainly kill phorid and sciarid flies and many growers use them regularly.

Their effect on Cecid larvae, mites and springtails is more doubtful, but there may still be scope for improvement in the form of dispersion and technique of application. These pests may prove to be susceptible if contact with the insecticide can be made more effective. The development of DDT and benzene hexachloride for some purposes was so rapid under the strain of war-time needs that we are apt to expect too much when considering their application to other specialized fields.

The older insecticides will not disappear entirely; the rapid knock-down action of pyrethrum retains its special value and has not been equalled by the new insecticides. Combinations of old and new insecticides may be expected to make the best use of their individual properties, and intermittent use of several of them may be necessary to overcome acquired resistance to one in continuous use.

Benzene hexachloride has the special advantage of combining some fumigant action with its contact and stomach toxicity. Some doubts

have been expressed about the effect of DDT on mushrooms and on the mycelium, and some growers have abandoned its use on account of the spotting which they observed on the caps after using DDT dusts.

An inquiry and a small-scale experiment conducted by the Mushroom Growers' Association (Atkins, Edwards and Sparkes, 1949) produced no conclusive evidence of injury by DDT. Recent work by Bels in Holland and Weigel in America suggests that DDT can be used effectively in small doses without injury, but when applied at 1 lb. per 1,000 sq. ft. as a surface treatment (Weigel, 1949) or mixed in the compost, 1½ lb. DDT per ton (Bels, 1948), it does reduce the yield. Unsuitable formulations may be injurious at lower concentrations. American workers particularly are also concerned about the possibility that toxic amounts of DDT may be absorbed by the mushroom.

Doubts about tainting by benzene hexachloride have been dispelled by its continuous use on a number of British farms for several years without any complaints from consumers.

There are other new insecticides, such as azobenzene, parathion, hexaethyl tetraphosphate and tetraethyl pyrophosphate and the systemic insecticides, which may fill any gaps left by DDT and benzene hexachloride. Their effect on the mushroom is less certain, but HETP has been used a few times to control tyroglyphid mites without any apparent ill-effects on the mushroom crop. It is reasonable to expect that in a few years the mushroom grower will have a quick and effective antidote for any pest which may trouble his crop. The elimination of flies and mites will also tend to reduce the spread of disease.

Progress in Cultivation Several advances in general cultural methods have been initiated as a direct result of scientific study. The addition to composts of gypsum (up to 28 lb. per ton), adopted as routine by many mushroom growers, was suggested by Pizer (1938) as a result of his study of composts in which the mushroom would not grow. He found that calcium ions flocculated the colloidal material which was making the composts "greasy", and he suggested that gypsum was particularly suitable to prevent greasiness because of its favourable solubility, high enough to be effective without any risk of local excessive concentration. All composts do not need gypsum, but it is an excellent form of insurance against the risk of greasiness.

Another development arose from the combination of traditional methods and Lambert's (1941, 1942) study of the conditions in fermenting mushroom composts. It has long been the practice of some growers to "peak-heat" their houses immediately after filling. The compost at this stage usually ferments, and with some artificial heat the temperature can be raised to any desired extent. The usual object is to reach 120°–140° F. and to maintain it for 24–48 hours. Lambert studied the distribution of temperature and aeration in compost heaps, and their effect on the growth of mushroom mycelium in samples from different parts of the heap. He found that aerobic fermentation at 120–140° F. gave the best compost, and that this fermentation would improve compost which had been fermented anaerobically or at other temperatures. This established a sound basis and defined the conditions wanted in the traditional "peak-heat". From it Lambert went on to develop a technique of rapid fermentation which saves time and reduces losses of manure during composting. The manure is composted in a stack in the usual way for 7–14 days, and is then made up into beds in the house. Heat is applied, often by blowing in steam, to raise the temperature of the compost to 120°–140° F., which is maintained

for a period up to a week, according to the condition of the compost. Considerable skill is needed to control the fermentation and to judge when to stop it. Many American growers have adopted the rapid fermentation method, and they cool off the compost as soon as its *p*H falls below 8. The larger size of most American mushroom farms favours their national inclination towards mechanical and instrumental control, and they accept such methods more readily than do British growers. Some British growers regard prolonged fermentation in the house as a waste of cropping space and time. A few have tried it, but it has not become popular.

The introduction of the tray system must be mentioned, although it arose from the industrial outlook of American growers rather than from scientific discoveries. Using rapid fermentation and mechanized at every possible stage, it put mushroom-growing on a mass production factory basis.

A systematic investigation of casing soils is urgently needed. Bewley (1946) and Pizer and Leaver (1947) have studied this problem, but our present knowledge is quite empirical, and we are completely ignorant of the scientific principles which govern the action of casing soil. The problem is complicated by the intimate relation between watering and the nature of the soil. It has recently been reviewed by Edwards (1949).

Too little attention has been paid to the intermediate stages between the growth of mycelium and the final crop. Pizer (1937) distinguished three stages, mycelial growth, strand formation, and appearance of the mushroom, but after the mushroom is formed its rate of growth and the onset of ripening, represented by opening of the veil, both affect the final weight of the mushroom. Apart from their relation to commercial yield, a study of these stages of development individually should contribute much to our knowledge of the biology of the mushroom.

References

Atkins, F. C. *Verticillium on Mushrooms* (1945), (Midland Group Publications, Yaxley, Peterborough).

Atkins, F. C. *Major Diseases of the Cultivated White Mushroom* (1948), (Midland Group Publications, Yaxley, Peterborough).

Atkins, F. C., Edwards, R. L., and Sparkes, E. D. *New Insecticides* (1949), (Mushroom Growers' Association, Yaxley, Peterborough).

Austin, M. D. and Jary, S. G. *J.S.E. Agric. Coll.* (1933), **32**, 59, and (1934), **34**, 70 and 74.

Bels, P. J. Private communication (1948).

Bewley, W. F. *Ann. Rep. Exp. and Res. Sta., Cheshunt* (1946).

Costantin, J. and Matruchot, L. *Rev. gen. Bot.* (1894), **6**, 289.

Demolon, A., Burgevin, H. and Marcel, M. *Compt. rend. Acad. Agric. France* (1935), **21**, 464.

Edwards, R. L. *Mushroom Growers' Association Bull. No.* 15 (1949), 84.

Edwards, R. L. *Mushroom Growers' Association Bull. No.* 17 (1949). (In the press).

Hebert, A., and Hein, F. *Ann. Sci. Agric.* (1911), **6**, 2, 337.

Kligman, A. M. and Penney, J. S. *Phytopath.* (1943), **33**, 1090.

Lambert, E. B. *U.S. Dept. Agric. Circular* 609 (1941).

Lambert, E. B. *J. Agric. Res.* (1941), **62**, 415.

Lambert, E. B. *News Letter, Div. Mycol. and Dis. Sur. B.P.I., U.S. Dept. Agric.* (1932).

Lambert, E. B. *J. Agric. Res.* (1934), **48**, 971.

Lambert, E. B., Steiner, G. and Drechsler, C. *Plant Dis. Rep.* (1949), **33**, 252.

La Touche. Unpublished observation (1948).

MANNS, T. F. *Plant Dis. Rep.* (1947), **31**, 417.
PAINE, S. G. *Ann. appl. Biol.* (1919), **5**, 206.
PIZER, N. H. *J. Agric. Sci.* (1937), **27**, 349.
PIZER, N. H., and LEAVER, W. *Ann. appl. Biol.* (1947), **34**, 34.
SINDEN, J. W. *Penn. Agric. Exp. Stn. Bull.* (1938), 365.
SINDEN, J. W. *Penn. Agric. Exp. Stn. Bull.* (1946), 482.
SINDEN, J. W. Private communication (1948).
SINDEN, J. W. *Mushroom Growers' Association Bull. No.* 14 (1949), 21.
STOLLER, B. B. U.S.P. 2260221 (1941).
STOLLER, B. B. *Plant Physiol.* (1943), **18**, 397.
STYER, J. F. *Amer. J. Bot.* (1928), **15**, 246.
STYER, J. F. *Amer. J. Bot.* (1930), **17**, 983.
TERRIER, C. *Ann. Agric. Suisse, Publ. No.* 343 (1946).
TRESCHOW, C. *Dansk Botansk Ark.* (1944), **11**, 6.
TRESCHOW, C. *Dansk Botansk Ark.* (1941), **11**, 1.
TUCKER, C. M. and ROUTIEN, J.B. *Univ. Missouri. Agric. Exp. Stn. Res. Bull.* 358 (1942).
WAKSMAN, S. A. and MCGRATH, J.M. *Amer. J. Bot.* (1931), **18**, 573.
WAKSMAN, S. A. and NISSEN, W. *Amer. J. Bot.* (1932), **19**, 514.
WARE, W. M. *Ann. Bot.* (1933), **47**, 763.
WARE, W. M. and GLASSCOCK, H. H. *Agriculture* (1947), **53**, 353.
WEIGEL, C. A. Private communication (1949).
WOOD, F. C. Phytopath. (1937), **27**, 85.
WOOD, F. C. Phytopath. (1939), **29**, 728.

THE MINISTRY'S PUBLICATIONS

Since the date of the list published in the September, 1949, number of *Agriculture* (p. 288), the undermentioned publications have been issued.

BULLETINS Copies are obtainable at the prices mentioned from the Sales Offices of H.M. Stationery Office or through any bookseller.

No. 69 Onions and Related Crops (*Revised*) 9d. (10d. by post)
No. 95 Strawberries (*Revised*) 2s. 0d. (2s. 2d. by post)

LEAFLETS Single copies of not more than 16 leaflets (four in any one group) may be obtained, free of charge, on application to the Ministry, 1-3 St. Andrew's Place, Regent's Park, London, N.W.1. Copies beyond this limit must be purchased from the Sales Offices of H.M. Stationery Office, net price 1d. each (2d. by post), or 9d. per doz. (11d. by post).

Advisory Leaflets

Group II. Pests and Diseases of Farm and Horticultural Crops

(b) FUNGI
No. 271 Potato and Tomato Blight (*Revised*)
No. 346 Violet Root Rot (*New*)

Group VI. Other Subjects

No. 122 Sugar Beet: Sowing to Singling (*Revised*)
No. 347 The Preparation of Beeswax (*New*)
No. 348 Sugar Beet: Singling to Delivery (*New*)
No. 349 Spring Cabbage (*New*)
No. 350 Winter Cabbage and Savoys (*New*)
No. 351 Summer and Autumn Cabbage (*New*)

Animal Health Leaflets

No. 28 Fowl Paralysis (*New*—superseding Advisory Leaflet No. 272)
No. 29 Foot-and-Mouth Disease (*New*—superseding Advisory Leaflet No. 148)
No. 31 A Substitute for Dishorning (*New*—superseding Advisory Leaflet No. [illegible])
No. 32 Pulpy Kidney Disease (*New*—superseding Advisory Leaflet No. 325)
No. 33 Bovine Contagious Abortion (*New*—superseding Advisory Leaflet No. 93)
No. 34 Sheep Maggot (*New*—superseding Advisory Leaflet No. 4)

Marketing Leaflets

No. 105 Recommended Grades for Tomatoes (*New*) 2d. (3d. by post)
No. 106 Recommended Grades for Lettuces (*New*) 2d. (3d. by post)

OFFICIALLY APPROVED INSECTICIDES AND FUNGICIDES

Since the date of the list published in the October, 1949, issue of *Agriculture* (p. 338) the following names of proprietary products have been added to the approved list under the Ministry's approval scheme.

Miscible Tar Oil Winter Washes:		
Swift and Sure Tar Oil Winter Wash	Mark Smith Ltd.	**D 338**
Stock Emulsion Tar Oil Winter Washes:		
Pest Control Tar Oil Standard Winter Wash	Pest Control Ltd.	**E 313**
Copper Fungicides to be used as Sprays:		
Blitox Wettable Copper Fungicide	Pest Control Ltd.	**K 328**
Stock Emulsion Petroleum Oil Winter Washes:		
Edwent 66% Petroleum Oil Winter Wash	J. M. Stokes Ltd.	**S 339**
DDT Insecticides to be used as Sprays:		
Psylortox 250	Pest Control Ltd.	**AE 330**
DNC-Petroleum Oil Winter Washes:		
Edwent 1-5 Dinitro-ortho-cresol Winter Wash	J. M. Stokes Ltd.	**AZ 340**
Pest Control DNC Petroleum 1.3% Oil Fixed Winter Wash	Pest Control Ltd.	**AZ 316**
Pest Control DNC Petroleum 2.2% Oil Fixed Winter Wash	Pest Control Ltd.	**AZ 317**
Sterilite DNC Petroleum Wash	Wm. Butler and Co. (Bristol) Ltd.	**AZ 342**
Calomel Dusts (4%):		
ITP 4% Calomel Dust	International Toxin Products Ltd.	**BB 320**
Metaldehyde Slug Baits:		
ITP Slug Killer	International Toxin Products Ltd.	**BC 304**

Products D 9, E 44, K 93 *and* L 234 *have been withdrawn from the list by the manufacturers. In the October,* 1949, *List, product* O 170 *was erroneously given under Nicotine Sprays instead of under Nicotine Dusts.*

Ministry of Agriculture and Fisheries, Plant Pathology Laboratory, Harpenden, Herts. November, 1949.

Correction

The name of the farm referred to in Mr. P. G. Swann's article "High Quality Kale Silage-making" (September issue p. 262) should read "Easton Farm" not "Eastern Farm". Also we are now advised that this property is owned by the Commissioners of Crown Lands; Messrs. J. Horton and Sons are the tenants of the farm.

FARMING AFFAIRS

Official Seed Testing Station: 1949 Report The number of seed samples received for analysis at the Official Seed Testing Station, Cambridge, during the twelve months ended July 31, 1949, was 77,964, a decrease of 4,773, as compared with the previous year. The decrease was marked in the cereals and pulses group, but there was an increase in the grasses. Comparative figures by species groups are:

Species Group	1947–48	1948–49
Clovers	10,621	8,410
Grasses	8,607	9,138
Cereals and pulses	41,174	38,425
Roots and vegetables	21,822	21,234
Control samples	513	757
Total of all samples	82,737	77,964

Comparative figures of the total number of samples tested during recent years are:

1942-43	1943-44	1944-45	1945-46	1946-47	1947-48	1948-49
74,528	75,834	76,692	79,157	80,019	82,737	77,964

Many investigational tests are also necessary to solve problems connected with routine testing; during 1948–49 these numbered 1,988, as against 1,285 in 1947–48. Tests to determine moisture totalled 866, as compared with 939 in the previous year, and the number of celery samples examined for disease infection also showed a slight decline from 152 to 125.

"Head" samples received in connection with the Wild White Clover Certification Scheme numbered 30, while the type samples sown from certified pastures numbered 7. In the previous year the numbers were 30 and 26, respectively. The customary inspection of the plots sown down from "head" samples was made by the Plot Inspection Committee in July.

A Seed Testing Course was held from June 8 to July 11, 1949. Nineteen students attended, including three members of the Official Seed Testing Station staff. In the subsequent examination taken by twenty-one candidates, sixteen satisfied the examiners in both written and practical work; four passed in the practical examination but failed in the written papers; and one passed in the written papers but failed in practical work. In addition, three candidates who sat the written papers only (having passed the practical examination in a previous year) failed to reach the required standard.

Extra Cereals for Stock Feeding Increased supplies of coarse grain have been bought from non-dollar sources, and a special non-recurrent issue of extra cereal feedingstuffs will be made this winter for cattle, pigs and poultry, to offset the effects of this year's drought. It will also be possible to make some improvements in the ration scales for domestic pig and poultry-keepers, including members of pig clubs, until further notice. In view of the uncertainty of future supplies of animal feedingstuffs from non-dollar sources, however, *these changes in no way lessen the need for an increased tillage acreage and the maximum possible degree of self-sufficiency in the provision of animal feedingstuffs.* Details of the changes are as follows:

COMMERCIAL STOCK. *Fat Cattle.* To improve the condition of cattle being fattened for slaughter during the period January–June, 1950, inclusive, an allowance of 4 cwt. of cereal will be given on application (before December

15) to the County Agricultural Executive Committee. The issue will be in 1 cwt. cereal coupons per beast per month for the four months beginning December.

Dairy Cows. The "cereal deduction" of 60 lb. of cereal per cow per month will be suspended completely during the two months December, 1949, and January, 1950; this will have the effect of reducing the level of self-sufficiency in cereals to that required in protein, namely, the first half gallon per cow per day. During the period February–April, 1950, inclusive, the level of self-sufficiency in cereals which farmers are expected to attain, i.e., the first 1⅛ gallons of milk per cow per day, will be reduced to the first gallon. The "cereal deduction" for these last three months will thus be reduced to 48 lb.

Calves 6–12 months old being reared for Milk or Beef. From December, 1949, to April, 1950, inclusive, the monthly ration will be increased by ¼ cwt. of cereal, bringing the ration up to 1 cwt. of cereal and ¼ cwt. of protein.

Commercial Pigs and Poultry. A supplementary issue of cereal amounting to 50 per cent of the total combined protein and cereal ration already issued under the basic and extended schemes for the period September–December, 1949, is being made in cereal coupons without the need for application.

DOMESTIC PIGS AND POULTRY. Because of the increased supplies of coarse grain the following revised scales will apply from January 1, 1950, until further notice:

Pig Clubs. The monthly ration of pig food will be increased from 70 lb. to 84 lb. per pig, and rations will be allowed for a second pig if kept by club members.

Other Domestic Pigs. The monthly ration will be increased from 56 lb. to 70 lb. and will in future consist of balanced pig food as supplied to pig clubs.

Domestic Poultry. The monthly allowance of balancer meal will be increased from 4 lb. to 5 lb. for each surrendered shell egg registration.

Potash Supplies To meet the ever-increasing demand for potash, special efforts have been made to import supplies early this season. These efforts have been so successful, however, that stocks are piling up at the fertilizer works and stores, and unless more orders for immediate delivery are placed by farmers, imports will be slowed down. All growers with storage accommodation are therefore asked to take immediate delivery of their potash fertilizers.

Nature Month by Month : December There is a nip in the air this morning, and when I got up the farmhouse roof was white with frost. The grass tufts still crunch pleasantly underfoot. Our neighbours are out with guns and ferrets; rabbits should bolt well on a day like this. The good red Devon earth, ploughed and waiting, is bright in the winter sunshine. Across the field there flies a prospecting crow, like other daytime birds finding it necessary to work harder for a living on these short December days. For the wood-pigeons the lean times have come, and before long they will be at the winter greens.

The trees are stark and bare, and the cart-ruts in the lane are filled with dead, brown leaves. Yet even now, I think, I could find a dog-violet or

two under the more sheltered banks. More than once I have seen them blooming in December, and primroses too. In the crannies of the old garden wall some flat discs of pennywort still show green.

Save for those dancing gnats which came out during a mild spell I have seen no insects on the wing for some weeks past, although doubtless there have been some male winter-moths around the lighted windows at night.

Darby and Joan, our barn-owls, sleep by day in the old dove-cot where they reared their young last spring. At night they have good hunting in the farmyard, and many a mouse falls to their talons. Darby has a trick of cruising under the farmhouse eaves, now and then flushing a roosting sparrow as a change of diet; but mostly rodents are his meat.

If really bad weather should come the tough little moorland ponies will drift down to the village in numbers in search of better provender. Already some are in the lanes, busy on the grass verges. The moorland foxes, too, are likely to visit us at this season. Living is hard on the Moor in winter, and at night we must look to the fastenings of our fowl-houses.

The river is fairly quiet, now. In the sandy margin at a bend there are some footprints as evidence that an otter passed that way last night. The prints were not there yesterday, nor, if I know otters, will there be any fresh ones there tomorrow. Heron, dipper and kingfisher are busy in the upper reaches, and a really cold snap may bring in a mallard or two.

Christmas will soon be here again, and even in our village the small boys will raise their shrill uncertain voices in praise of the good king "Wencerslosh", knowing well that no matter how indifferent their performance they will pouch a copper here and there. Soon, too, the days will lengthen and Nature's great cycle start once more.

F.H.L.

BOOK REVIEWS

Pests of Farm Crops. J. H. STAPLEY. Spon Agricultural Series. 21s.

The link between science and agriculture has never been closer than at the present time, because more scientists appreciate the agricultural viewpoint and more farmers realize that agricultural progress is dependent largely upon scientific work. This link is forged largely by books which deal with the "field" aspects of the applied science concerned, and Mr. Stapley's book is a good example. It is "written primarily to interest farmers and all others who meet pests in the open field".

It commences with a survey of the more important "insect" pests of farm crops, with a key to their identity, based upon the nature of the injury they cause. Then follows a brief description of insects in relation to their food and environmental conditions, an account of the principles underlying control methods, and concise information on the chief insecticidal substances and their use. The main portion of the book deals with the chief insect pests of crops, including eelworms and other non-insect animals. Mammals and birds do not come within the scope of the book. The treatment of the subject matter is based upon entomological classification and not under crop headings, but this classification is introduced by a concise explanation, together with an account of insect structure and development.

It is not a text-book in the accepted sense, neither is it simply a book to be read. Data from field and laboratory trials are frequently quoted ; there are many references to scientific work and a useful index to authors, all indicating that the subject is approached from the angle of the advisory worker. This indeed is the atmosphere of the whole book. Its objective is to show how the applied scientist arrives at his practical conclusions.

Many farmers who are prepared to spend time seriously with it will find this volume most useful for reference ; agricultural students and field advisory officers should certainly not omit it from the library.

S.G.J.

Sheep Husbandry. ALLAN FRASER. Crosby Lockwood. 25s.

A picturesque and original personality, a distinguished scientist with an extensive background of practical experience and a gifted writer, Dr. Allan Fraser is always readable, often provocative and generally convincing. He distrusts the dogmatism of modern science as applied to our oldest industry. When there is a conflict of opinion between scientist and practitioner it is too often assumed that the latter is necessarily wrong. "Traditional knowledge of sheep farming has brought mutton and cheese to our table, clothes to our wardrobes regularly and unfailingly for countless generations. To have done this so successfully it must, in the main, be in accordance and keeping with the true laws of biology . . . Will science do better? That is still a question".

In regard to stock breeding, Dr. Fraser's views seem to be more or less in harmony with those of most modern geneticists. But he is frequently critical of current methods of selecting and rearing rams of hill breeds, where breeders base their selection on standards little related to utility. He stresses the point that the larger portion of the female progeny is returned for breeding on the hill and must inherit some of the properties of their sire. If they, like their sire, tend to lowland type their nutritional demands will not be too exacting for the hill climate and hill fare, which they will have to tolerate during the five or six years of their reproductive life.

By contrast, under the lowland folding system, ram breeding has been combined with the commercial production of mutton and wool within the same flock. Now, however, because of economic conditions, the folded flock seems destined to vanish except for ram breeding, and is being replaced by "grass" sheep, commonly Half-breds or Cross-breds put to a Down ram. This has the disadvantage or inconvenience that the flock has constantly to be renewed. The Scottish Half-bred ewe (Border Leicester x Cheviot), is unbeaten for this purpose, but Dr. Fraser admits that certain other breeds with hill blood in their ancestry are proving satisfactory for grassland where a self-contained flock is preferred to a "flying" one. He mentions specifically the Clun Forest and Kerry Hill.

It may be that for new pastures of high productivity the most economical self-contained grass breed has not yet been evolved. The most prolific and best mothers from the milking standpoint are probably Border Leicesters and Dorset Horns. Why not combine the two, using the Border Leicester ram to get hornless progeny?

As regards nutrition, Dr. Fraser maintains that science has still more to learn from the practical sheep feeder than vice versa. Animals vary in their powers of digestion and metabolism. Consequently, "in all systems of rigid rationing, everybody gets either too little or too much. Only the theoretical completely average individual gets just enough —but today it is fashionable to strike an average and call it science". Yes, but needs must when the devil drives. Anyway, with sheep the flock is the unit and exactitude in feeding is out of the question.

Dr. Fraser is scathing about grassland research. It has been erected into an independent subject of study concentrating on production with the result that it tends "to give greater consideration to the grass than to the stock that graze it . . . A pasture that can only be maintained in excellence by remaining ungrazed at the times of year when stock need grazing most is not excellent pasture at all . . . The real probiem of all pasture as a basic food is its seasonality".

The experts' retort to this would, I suppose, be "management and efficiency" (would it also include cost?)—a special seed mixture for every season and silage to help out in winter, but before dogmatizing or particularizing on this aspect, Dr. Fraser thinks they might get aroused and sit at the sheepman's feet. "The facts are that an intelligent, observant, and experienced shepherd or flockmaster knows far more about sheep, as sheep, than any scientist, simply because he has studied the sheep as a sheep, and it really is, as an integrated unit and not as a mere collection of analysed parts. He knows . . . that breeding, feeding, and shepherding of sheep have as much to do with sheep disease as has any specific germ or virus".

Science, practice and philosophy—all go to the making of a good shepherd and a highly stimulating, enlightening and entertaining book.

J.G.S.

Wheatsheaf and Willow. NORMAN WYMER. Lutterworth Press. 15s.

Many books have been written on rural England, but in *Wheatsheaf and Willow* I think Norman Wymer has provided a book packed with an unusual amount of interest. You will be taken at great pace through the towns and countryside of the Eastern Counties and parts of the East Midlands and your interest will be kept with tales, custom and history, that you find yourself quickly realizing that you know little of England other than its roads. This book will help you to discover England.

Mr. Wymer gets behind the picture postcard scene and in a brief fascinating way, the stories of bygone years and the way of present-day life are told with a depth of sincerity which cannot fail to arouse a new interest in an already familiar scene.

In this book (the second of a series) Mr. Wymer bids you follow him into Essex, which he describes as so near London and yet, spiritually, "so remote from all that is going on in the outside world," and this remark is, I think, a clue to the theme of the book. Break from the roar of the traffic and read of strange country cures; of its farming and old harvest ceremonies; Morris dancing and the Dunmow Flitch. Into Suffolk and hear of its past woollen fame; the survival of its rural crafts; of its shepherds and wildfowlers. North into Norfolk, rich in her architecture, and read of her long battle against floods; of the ghosts of her noble houses; of Coke and Townshend and other famous names that spelt progress to the countryside. Through Cambridge and the open-dyked country of the Fens, you will read of the past history of Ely and the charm of Cambridge and its colleges.

You will be taken on through Huntingdon, Northampton, Rutland, Bedford, Hertford and Lincoln and follow the scenes through the hunting shires, and be reminded of the counties' associations with Cromwell, of Robert Bakewell, of Izaac Walton, of kings and noble lords.

Wheatsheaf and Willow will help you when you hear of the martyrdom of St. Edmund or see dancing around a maypole, to understand that this is history and the survival of tradition and custom so dear to the English. *Wheatsheaf and Willow* should not fail to interest a wide public.

P.J.O.T.

Keeping Chickens for Profit. ALAN THOMPSON. Nicholson and Watson. 6s.

Amateur poultry-keepers will welcome this addition to the series of *Country Books* edited by Brian Vesey-Fitzgerald. It is both practical and helpful and well worth the price charged for it.

The author has covered a fairly wide field relating to ordinary poultry-keeping, and the title might perhaps more appropriately have been " Keeping Poultry for Profit".

The book contains some excellent photographs and a large number of drawings by that eminent poultry artist, Bruff Jackson. These are particularly helpful and likely to be studied by readers with interest.

H.H.

A Horticultural Who Was Who. A. SIMMONDS. The Royal Horticultural Society. 3s

Who *was* Mr. Cox, whose "orange pippin" constitutes such a delightful legacy to all who appreciate a good apple; who *was* Mr. Bramley whose "seedling" has attained such lasting fame in the kitchen; and, more intriguing still, who was Annie Elizabeth? Was she wife or daughter of yet another of that engaging band of men in response to whose magic touch, seemingly, nature produces her choicest fruits?

Now, at last, thanks to Mr. Simmonds, we know all that is available about such worthies as Mr. Cox and Mr. Bramley, and others of pomological fame—Charles Ross and James Grieve. Sadly we learn that a child who died after a bare thirteen months' life had from her father a living memorial for ever in the form of a graceful orchard tree. But if Annie Elizabeth's fame is attributive, Mr. Bramley's, we learn, is vicarious. The honour of bringing a famous apple into the world belongs, really to Mary Ann Brailsford, of the same village (Southwell) where Mr. Bramley lived; for clearly it was her hands that sowed the seed in a flower pot.

Mr. Simmond's account of his patient research and sifting of facts and rumours, the wheat from the chaff, in order to acquire the truth, is very readable. It is difficult to put down such a book, and reading on we find ourselves in the world of flowers, encountering such well-known names as Mrs. Sinkins, Dr. Jules, Dorothy Perkins, and William Allen Richardson. We make the acquaintance of the men and women who originally bore these names. "What's in a name? That which we call a rose, by any other name would smell as sweet". But that Kentucky gentleman, of whom his friends said "He runs to roses," deserved his commemoration through such shapely and fragrant flowers as William Allen Richardson can give us in June.

There are chapters devoted to amusing details of two great gardeners, Paxton and Forsyth; the latter is pictured quixotically busy with the creation and marketing of a composition (Forsyth's "plaister") for treating the wounds of fruit and other trees—evidently he ran as a sideline a kind of quack-doctoring of trees.

All too soon this little book of engaging interest comes to an end with a study of George Cruikshank's coloured etching, produced in 1826, depicting in caricature style a meeting of the Horticultural Society. Under Mr. Simmonds's scrutiny many contemporary "characters" emerge from this drawing for our entertainment.

There will be many readers who, like myself, will wish there were more of this book than its 80 pages. For whatever the subject, the author's ingenuous style of writing attracts and holds the reader. But the author seems happiest, and so are we, when on those little pilgrimages to the former abodes of Mr. Cox, Mr. Bramley, and Annie Elizabeth.

A.H.H.

Vegetable Growing. J. E. KNOTT. Henry Kimpton. 20s.

The fact that this is a book about vegetable growing in America does not detract from its merit as a useful work of reference for growers in this country. It endeavours to cater for the small producer as well as for those growing vegetables under field conditions. A wide range of vegetables is covered, and the classification by temperature requirements should make a particular appeal to growers in climatically favoured areas, or to those with "forwarding" structures;

Specialist information is given in such sections as those on Sweet Corn, Cucurbits, and Beans, and the advice on the principles of production is equally applicable to this country. This is supported by useful data, in tabular form, on such matters as the quantities of seeds and plants required, with details of crop yields.

One Table shows the relative values of green manures, and it is interesting to note that in America much greater use seems to be made of nutrient solutions on seedlings. Useful information is given on this technique as well as on the general use of fertilizers.

Comprehensive cultural details are given under the various vegetable groups, and the suitability of varieties on the long and short-day principle are discussed. Various labour-saving methods are also a feature of these detailed cultures. The cultural advice embodies most of the recent findings on pest and disease control and on weed suppression by cultural and other means, including growth-regulating substances and the use of flame guns.

Great emphasis is laid on good seed stocks and the right selection of seed parents. Seed incubation and testing, including the "rag doll" method, are described. Tables show plant expectations from given numbers of seeds. Some of the figures are surprisingly low.

Seed pelleting for easy drilling is discussed, and bulk increases up to thirty times the weight of the seed are mentioned. Uniformity of spacing is said to be outweighted by the disadvantage of increased bulk.

In view of the book's attractive cover, it was disappointing not to find more information on the mechanization of vegetable growing. The home producer imagines that he has much to learn from the Americans about labour saving and the advantages of large-scale production, and greater detail of some of the operations illustrated would have added to the the value of the publication.

Marketing, mainly as it affects the small producer, is only briefly covered, but the section dealing with waxing, cold storage, etc., of produce should be of great interest to growers in this country who wish to extend their marketing season or to minimize their losses during glut periods.

A particularly valuable Table gives the optimum storage temperatures and maximum periods for which various vegetables can be held. This, alone, makes the book worth while.

H.W.A.

Insect Pests of Glasshouse Crops, HERBERT W. MILES AND MARY MILES. Crosby Lockwood. 15s.

There has been a long felt need for a revised edition of this well-known book on insect pests of glasshouse crops. As Professor of Horticulture at Wye College, Dr. Miles has continued to keep in touch with economic entomology and ever since the first edition has been out of print, advisory entomologists as well as teachers and growers have looked forward to the appearance of a second edition of this work.

There will undoubtedly be general approval of the modified presentation, the alphabetical list of crops, now coming as it does at the end of the first chapter, will make for ease of reference and the general chapter on methods of pest control is better situated near the beginning of the book.

Most of the advances recently made in glasshouse pest control are briefly discussed, but the authors warn growers not to be too hasty to be 'off with the old and on with the new'. Many readers, however, will be disappointed to find only brief references to the newer insecticides and new methods which have now had many trials and which already may be said to have become established. Only very brief mention is made of the use of smokes and aerosols and the control of the greenhouse red spider mite with azobenzene is dismissed in two lines.

Outstanding features of the first edition of this work were the quality and number of illustrations and the authors and publishers are to be congratulated on maintaining the high standard originally set; there are twenty-four plates comprising ninety-two excellent illustrations of glasshouse pests and the damage they do.

I.T.

BOOK REVIEWS

John Innes Horticultural Institution Annual Report 1948.

During the year 1948 the removal of the John Innes Horticultural Institution from Merton to a larger site at Bayfordbury, Hertfordshire, began in earnest. The task of moving a research centre is no small undertaking, and much care and forethought are required in order not to break unduly the continuity of investigations in hand. Work at the John Innes Institution has always been of a twofold nature. First, there are the investigations into matters of immediate practical importance to the grower of fruit, vegetables and flowers, notably fertility and pollination in fruit plants, the growing of sweet corn and tomatoes, and the development of special seed-raising and potting composts. Second, there is the valuable scientific work concerned with the genetical constitution of a wide range of cultivated plants—work that has not only provided new knowledge but has led to a clearer understanding of the science of plant breeding, so long a tangled path with many blind alleys for the unwary. The Director and his staff are deserving of congratulations in that there has been no appreciable break, no hiatus as it were, in the many valuable investigations.

The report states that about 65 acres at Bayfordbury have been taken over for use since the property was acquired in 1945-46. The planning of this area includes the allocation of about 5 acres to the establishment of a National Rose Collection in co-operation with the Royal Botanic Gardens, Kew, and the Royal Horticultural Society's Gardens, Wisley.

In the Pomological Department, Mr. M. B. Crane has continued his genetical and breeding studies of fruit plants, notably pears, raspberries and tomatoes.

In the Genetics Department, work under Dr. K. Mather has been concerned in recent years mainly with the organization, properties and analysis of the polygenic systems which control quantitative or continuous variation. As was to be expected, a number of diverse lines of experiment have developed from this work. In October of the year under review Dr. Mather left the Institution to take up the newly-created chair of genetics at Birmingham University.

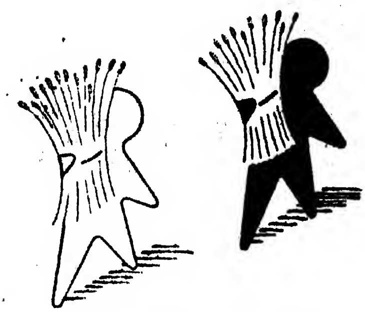
An interesting feature of the Cytology Department's work is the inquiry undertaken into the origin of garden daffodils—work that involved a painstaking survey of representative forms of the enormous number of cultivated clones whose ancestors are two highly polymorphic species of *Narcissus*.

Reporting generally on the work of the Institution, the Director concludes with some interesting observations on the Lysenko-Michurin claims, which deserve close attention. As is now well known, Lysenko claims to have achieved what may be termed "vegetative hybrids" by grafting together different species of plants and raising seed from them. The workers at the John Innes Institution have had very considerable experience of cross-grafting, and have closely studied the subject of cytoplasmic inheritance. So far they have encountered no evidence to support the claim by the Michurin-Lysenko school that cross-grafting can be a means of producing new and improved plants of a true hybrid nature.

This report of the John Innes Institution for 1948 is worth close study by all who take an intelligent interest in scientific horticulture.

A.H.H.

Printed in Great Britain under the authority of HIS MAJESTY'S STATIONERY OFFICE by C. Nicholls & Company Ltd., The Philips Park Press, Manchester, London and Reading



Weeds away!

Valuable crop increases, cleaner cultivation, lower labour costs—all are proved achievements of selective weed-killing. Although the technique is comparatively new, the wide range of control already achieved has established selective weedkilling as an important economic factor in modern farming routine. Shell selective weedkillers may be used with confidence on a variety of crops in the certainty that—barring disasters of weather—the cost of application will be repaid multifold in higher yields and richer harvests.

Shell Weed Killer M, (liquid or dust), containing MCPA, is safe in use and non-poisonous to stock. Applied to cereals and grassland, or linseed and peas at various recommended concentrations, it destroys many kinds of common weeds and stunts the growth of many others. Other selective weedkillers are in course of development and you are invited to apply for details of these products.

Shell Chemicals Limited
(DISTRIBUTORS)

112 Strand London WC2 Tel: Temple Bar 4455

Write for Technical Information Sheet No. 283, "Notes on Shell Weed Killer M." Shell Technical Service is always at the disposal of farmers to discuss problems of weed-killing and the control of insect pests and fungal diseases.

H20

SANIZAL for farm disinfection

ONE GALLON TIN

9/6

Approved by the Ministry of Agriculture and Fisheries

NEWTON CHAMBERS & CO. LIMITED
THORNCLIFFE, SHEFFIELD

Quality and High Productivity are the Outstanding Features of

MARSTERS'

PEDIGREE STRAINS

Wheat, Oats, Barleys and other Farm and Market Garden Seeds

C. W. MARSTERS LTD.
Plant Breeders and Seed Specialists
KING'S LYNN · NORFOLK